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CIRCULATION THIS ISSUE OVER 16,500

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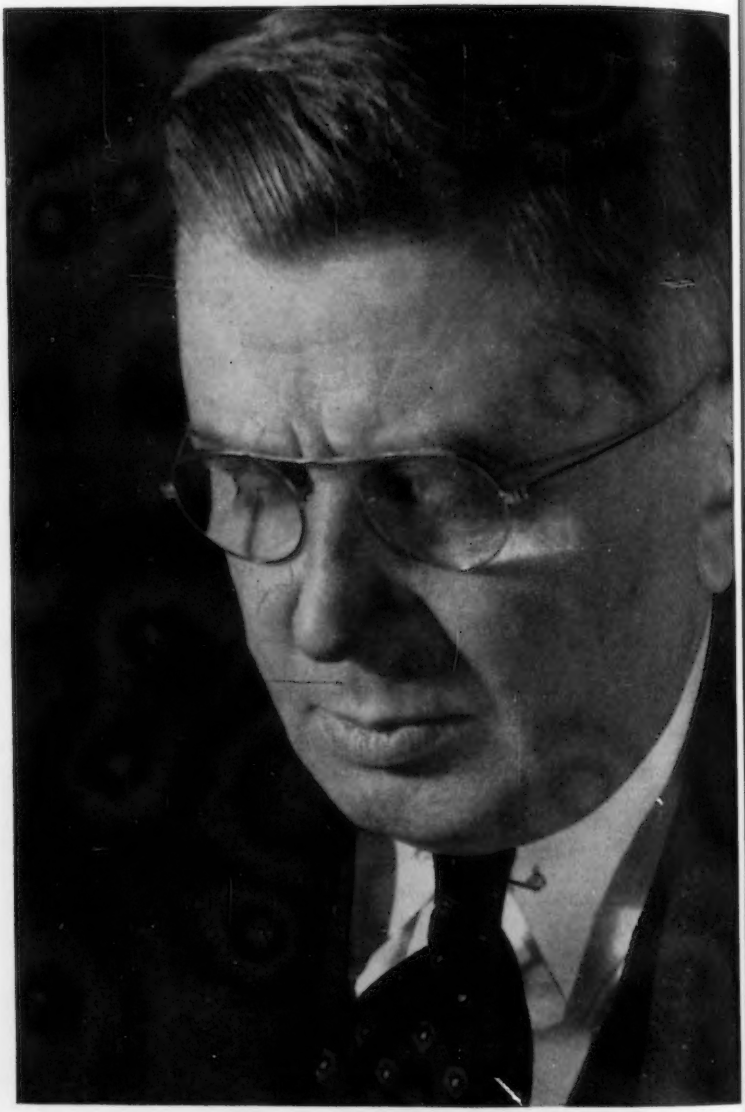
GREETINGS FROM THE NATIONAL PRESIDENT

The Society of the Sigma Xi, having successfully passed its fiftieth milestone, has every reason to look forward with confidence to the coming years. This does not mean that the organization can afford to be content with past achievements, nor that there are no problems awaiting solution. Quite the contrary is the situation. Confidence may be felt for the future in the belief that correct answers to our problems will be found, and therefore that past achievements, splendid as they are, will be excelled in the years that lie ahead. Every type of association, if it is successful and continues to expand, will be faced periodically with important problems of organization and policy. So it has been with Sigma Xi at various periods during its past history, and such is the condition which confronts our Society at the present time. For over a a year a National Committee on Organization and Planning, with Professor R. A. Gortner of the University of Minnesota as Chairman, has been concerned with the Sigma Xi of the future. The recommendations of this Committee will probably be ready for presentation to the Society at the next annual meeting. It would be very helpful if the chapters, during the coming months, would carefully consider the national policies of Sigma Xi and suggest possible changes to the Committee. Undoubtedly many of these would be of great value to our organization and the ideal to which it is dedicated: the encouragement of research in science. To this worthy aim, the executives you have chosen pledge their wholehearted endeavor.

Faithfully yours,

George A. Baitsell.

New Haven,
February 1, 1938.



Angleton—Yale Literary Magazine

GEORGE A. BAITSELL
National President
The Society of the Sigma Xi

GEORGE A. BAITSELL

President Baitsell is Iowa born and educated. His graduate work was done at Yale, where he has been a professor of biology since 1928. He is a member of the corporation of the Marine Biological Laboratory, served as physiologist in the Army-Navy Gas Investigation, was a captain in the Chemical Warfare service during the Great War. He is the author of several manuals of biology and the editor of the Evolution of Man, and the Evolution of Earth and Man. He has served the Society of the Sigma Xi as a member of the Executive Committee, of the Semi-centennial Committee, and as chairman of the Committee on Lectures and Publications, and as a member of the Committee on Policy.

THE WISDOM OF THE MIND*

JOHN M. FLETCHER

The title of this paper will be familiar and, I hope, suggestive to all who are acquainted with Dr. W. B. Cannon's book, "The Wisdom of the Body." The use of the term wisdom in this paper, as in Cannon's book, is of course a restricted one. Webster defines wisdom as the ability to judge soundly and deal sagaciously with facts especially as they relate to life and conduct, or otherwise phrased, wisdom is knowledge with the capacity to make due use of it. Of course Cannon could not ascribe to the body wisdom in this sense. It can scarcely be said that the bodies of animals or men possess the knowledge or the ability to judge soundly in the ordinary meaning of such terms. So far as the mind is concerned, of course, such abilities could not be considered out of place, for mind is precisely that aspect of the living human organism which we may define as the capacity to judge soundly and to acquire knowledge. But, the wisdom of the mind which we are here attempting to discuss does not imply the accumulation of information, nor does it imply a conscious action of intelligent foresight. Rather do we mean to speak of that kind of wisdom of the mind which seems to function as automatically and in some instances as unconsciously as the wisdom ascribed by Cannon to the body, and which is related in the same way to its protection against injury.

Without being deterred by the teleological implications of the innumerable self-defense mechanisms to which the body resorts in the presence of injurious agencies, Cannon sets forth the facts concerning the existence of such devices in an impressive array and with unimpeachable evidence. Dr. Carrel rehearses many of the same sort of facts in his recent more popularly read book, "Man the Unknown." In Carrel's book, however, speculation seems so frequently to run ahead of facts that one is not encouraged to use it as a source of authoritative references.

In his address delivered at the installation of the Tulane University chapter of Sigma Xi in 1934, Professor Ernest Carroll Faust discussed the topic, "The Human Body's Defense Against Disease," and indicated how its defense mechanisms operated in various infections. His address, as you know, was published in the SIGMA XI QUARTERLY, June, 1934. I have long wished that the mental side of this dramatic story might be told. Of course I cannot hope to accomplish such a task on this occasion. The most that I can expect to do is to present some bits of evidence that there *is* a mental side, the most of which remains to be discovered.

In Cannon's book we read the story of the maintenance of delicate balances and vigilant defenses against invading toxins and other forms of injury to the organism, and also the body's equipment for maintaining equilibrium or homeostasis in its functions, without which survival would not be possible. Man's body, for example, may be exposed to 257 degrees, Fahrenheit, of heat without change in internal temperature. Arctic animals, on the other hand, may be exposed to cold as low as 31 degrees below zero without appreciable fall in

* Delivered before the Society of Sigma Xi, Tulane University, New Orleans, La., November 17, 1937.

bodily temperature. The heat produced in the body by extreme muscular effort would, if not promptly dissipated, cook its albuminous substances, so that they would, we are told, become as stiff as hard-boiled eggs. The lactic acid produced by such exercise would neutralize the alkali in the blood with disastrous results. The brain, the nerves, the heart, lungs, kidneys and spleen cooperate to check such sudden and disastrous changes and to maintain homeostasis of temperature.

Many other delicate balances must also be maintained. The body must keep a constant supply of water, salt, sugar, proteins and fat. It must stand ready to manufacture anti-bodies of indefinite varieties for combating invading pathogenic organisms. The adaptive processes carried out in the body, the innumerable ways in which it repairs damages, removes dead tissues and foreign bodies, have made modern surgery possible. On the basis of this knowledge horses have been made beasts of burden in a new sense, while other creatures have been domesticated to the higher purposes of healing and life-saving.

The intention of this paper is, in pursuance of the notion suggested in the title, to point out that the mind, no less than the body has its devices, mechanisms, or modes of response by which it seeks to maintain its equilibrium and to defend itself against pain and injury. The patron saint of medicine was born in the fifth century B.C.; the patron saint of scientific psychology was born in 1832, A.D., and set up the first laboratory for experimental work in this field in 1879. Not for some years, therefore, can anyone hope to parallel the work of Dr. Cannon and write as full and precise a book on The Wisdom of the Mind. When such a time does arrive, the brilliant achievement of medicine in prolonging the physical life expectancy of human beings will have been matched by an equally important achievement in the prolongation of mental vitality and in the improvement of the quality of human existence. But that we are by no means lacking in facts concerning the wisdom of the mind in its defense against disease I shall attempt later to show. Permit me first, however, to say that the entertainment of such a hope as this does not rest entirely upon analogical reasoning, but upon direct observation of facts, in independence and generally in disregard of the analogous facts concerning the defenses of the body.

The use of analogy, as everyone knows, has led to many great scientific discoveries, and, as Alexander Bain said, the capacity to make use of it is a mark of great minds. Analogy, however, while usually suggestive and sometimes convincing, is never proof. Hence, by reason of these very qualities, it may be subtly misleading. It has been particularly misleading in psychology.

The analogies most commonly employed in psychology are naturally those derived from the medical sciences. The history of the relationship between psychology and medicine dates back into the stages of the development of knowledge in general at which lines of distinction between medicine, philosophy and religion had not yet appeared, the physician in primitive society being at the same time the thinker, the ritualist and the healer. The lines of demarcations between these functions are not even yet clearly drawn, for they all still have some forms of ritual, some forms of philosophy, and they all endeavor to do healing of some kinds. But at any rate philosophers of today do not write

on medical topics, and physicians as such are not expected to make contributions to philosophy. These three ancient disciplines of learned minds found a field of common interest in the perennially urgent question of the relationship between bodily states and mental states. Out of the joint inquiry into this problem, renewed as it has always been, from century to century even up to our day, psychology may be said to have had its origin. That ancient question is involved in the issue before us. Does the old adage, for example, about a sound mind in a sound body mean that, given a sound body a sound mind necessarily follows, as we seem to imply when we hang up mottoes in our gymnasia? Or is it true that the mind and the body each has its own laws of health, its modes of self-defense, its wisdom, and that ignorance or disobedience of the one, as of the other, carries its own peculiar penalties?

Moreover, psychology, being a young science, has always been tempted to borrow the methodology of, and to identify itself as closely as possible with, the older and better established sciences, in order to secure a little reflected prestige. From the faculty psychology of Sir William Hamilton to the use of geneticism as an heuristic principle by Hall, yielding to such a temptation, while it has checked off many blind alleys into which future investigators need not be enticed, has proved costly in time and resources.

It is nothing more than justice to add, however, that reasoning by analogy is not a fallacy originating always in psychology itself, but is quite often imported into it *ab extra*. The most conspicuous example of such an importation is the one for which we are indebted to Sigmund Freud.

I need not say to you that Freud has had a profound influence upon the literature, drama, art, social and political science, religion and morality of our day, as well as upon psychology. I cannot of course deal with his entire system in this connection. With the desire to make full acknowledgment of his contributions of abiding value I wish in the first place to call attention to the fact that in his incursions into the field of psychology Freud has ignored the established conclusions of others who have labored in that field, and secondly to point out that analogies stick out prominently in his conception of the nature and constitution of the human mind, in his theory of the causes of psychoneuroses, and in his therapeutic technics.

As to his theory of the nature of the human mind one sees in it many crude analogies derived from the study of anatomy. Freud's psychology is a sort of home-made organology, corresponding in some respects with the now passé doctrines of faculty psychology. The mind to him seems to be a sort of corporeal entity, with sub and super layers, in which mental materials may be shifted from one level to another, and which is seemingly capable of suffering localized lesions, which may, as he says, leave scars that remind one of the Charing crosses of London, which stand as monuments of grief for the dead queen of the old Plantagenet king.

Not only have mental processes become reified in the hands of Freud, but they have even become personified. He employs such beings as the id, a sort of *enfant terrible* of the soul, who is irrational and amoral and totally incapable of dealing with reality except in primitive ways. The ego is that aspect, or being, of the mind which, or who, does come into contact with the outside world and which attempts to make adjustments to it. The ego is rational in

the main, and in the main conscious and cognizant of objective reality. A third member of the group that makes up the human personality is the super-ego. In childhood we tend to identify a portion of ourselves with our parents and to act as we think they would have us act. This begets the super-ego and lays the foundation for the irrational acceptance of authority of every sort in adult life such as dictatorships and religious superstitions. The ego, as one author puts it,[1] is caught between the "irrational drives of the id and the irrational commands of the super-ego." Each of these three parasitic selves seems to have a personality of its own, each its own sense of values. The super-ego will suppress the drives of the id, which in turn will endeavor to circumvent the super-ego by expressing its urges in disguised forms. Meanwhile the ego may be caught between the upper and the nether member of the triumvirate with disastrous results.

There is still another member of this mysterious group, or mental staff, namely, the censor. This creature, if we may so call it, resembles the Socratic daemon in acting as a guardian of the entrance from the unconscious to the conscious mind. Thoughts and wishes being disallowed by the conscious mind are relegated to the unconscious mind and put under the guardianship of the censor, whose watchfulness they cannot escape except under the camouflage of symbolic disguises. The censor lets them by only when he fails to recognize them. To the now ancient faculty psychology the human mind was like a machine shop. To Freud it seems more like a menagerie. To modern psychology it is an organism, and, like the body, it has its peculiar modes of functioning, of adaptation, of self-protection, of wisdom.

This, very briefly told, is the structural make-up of the mind of man as conceived by Freud. That his conceptions are in many respects out of harmony with modern science in general and psychology in particular needs scarcely to be said. Just as the physical sciences have replaced the older notions of particles of stuff by centers and vortices of energy, so psychology, working independently in its own field, has found it necessary to abandon the notions of mental entities, and to attempt to explain its phenomena in terms of processes. So far as the resort to personification as a mode of exploration is concerned, one can only say that such a procedure would take us back to mythology. It is not so much Freud's facts as it is his method of explaining these facts that modern psychology doubts.

Freud's conception of causation of neuroses is somewhat less crude and objectionable scientifically. Leaving aside the notion that the mental corpus can be traumatized locally, and through repression may accumulate complexes, which, like foreign bodies or pus pockets, must be probed after and removed, drained or disinfested by the technic of psychoanalysis, one may come down to a very fundamental contribution, namely, that one's mental experiences and their residues have to do with one's health of body as well as of mind. In his first lectures in America Freud said that the victims of that baffling Pandora's box of human ills, hysteria, were suffering from "reminiscences." The establishment of this fact may some day be accounted as of comparable value with the work of Pasteur, Koch and others in the relation to the germ theory of disease.

As to his modes of treatment, Freud under the influence of Charcot tried the use of hypnosis on his patients. This he later abandoned. Under the influence of Breuer he adopted and tried out the method of catharsis, or the "talking-out" cure. From these first simple trials to the elaborate procedures of modern psychoanalysis which require, says Kubie,[2] an hour a day for from one to three years, there have been many developments. Meanwhile differing schools of psychoanalysis, such as those of Adler, Jung, Stekel, Burrows, Rank and others have sprung up. These we of course cannot consider here. We are considering the Freudian school for two reasons. In the first place, according to a dictum of the British Medical Society, "a psychoanalyst is . . . . a person who uses Freud's technique." In the second place, a general critique of psychoanalysis, the uses and value of which in certain instances may be admitted, does not fall within the purposes of this discussion. We are attempting here merely to take note of the false analogies in the Freudian psychology and the costly errors into which they have led and are leading us. One thing at least should be kept in mind, namely, that it is never justifiable to judge the validity of any therapeutic procedure by the results accruing from its use. Nature has a way of covering up mistakes. Moreover, suggestion is a potent drug, especially in those conditions with which psychoanalysts are called upon to deal. Freud admits that the faith-healing methods used at Lourdes, though based upon radically different etiological theories, have been more successful than his own.

In pointing out what seem to me to be instances of being misled by false analogies I shall confine myself to brief observations of clinical procedures based upon these analogies, and in use in current methods of dealing with mental maladjustments and behavior difficulties of the young. In this field I have done some service, and therefore feel that I have more excuse for speaking.

To Freud, as we recall, the mind seems to have a sort of corpus, which may suffer injuries from traumatic episodes. Experiences may be pathogenic.

> Unnatural deeds
> Do breed unnatural troubles.

When such things have happened, to Freud, as to Shakespeare, the logical course is to apply the remedies immediately to the pathology itself with a view to removing it.

> Canst thou not minister to a mind diseas'd,
> Pluck from the memory a rooted sorrow,
> Raze out the written troubles of the brain,
> And with some sweet oblivious antidote
> Cleanse the stuff'd bosom of that perilous stuff
> Which weighs upon the heart?

The fallacy concealed in such analogies, when it comes to dealing with actual mental maladjustments, is not far to seek. Along with the child we can take the cause as well as the symptoms of his toothache, or his tonsillitis to a clinic and have them both removed. They are both localized in him. But if he is suffering from a personality distortion or maladjustment, we may take him, but we can take neither his symptoms nor their causes to a clinic and

have them removed. His symptoms appear as a rule only under certain social exposures, and are discoverable only in his case history. In the clinic he may and generally does appear as an ordinary, and in many cases, even a model child. The problem child is not necessarily a sick child. He has no localized pathology inside of him which can be "plucked from" his memory, or "razed out" of his troubled brain by technics fashioned after the methods of the sick room or operating table. The principle underlying this assertion is now a familiar one.

One of the epoch-making discoveries in modern psychology revealed the fact that thought is always *about something,* and hence that the object of thought must always be considered a factor of the thought process itself. Thought can no more be separated from the thing thought of than motion can be separated from a moving object. The same law holds with respect to our emotional responses, and behavior patterns. Likewise, maladjustments are always maladjustments *with respect to environing conditions and situations,* not just maladjustments in the abstract, and hence they can neither be understood nor treated in disregard of causal sources, as one might treat a case of typhoid without knowing anything concerning the source of the infection.

Sometimes the causal conditions may be located in the domestic situation, sometimes in the school and sometimes in other social groups, to which the victim has been exposed. But no matter where they may be located, the specificity of their conditioning effects must be taken into consideration in devising a program of restitution. In order to be consistent with the psychological character of such difficulties one must think in terms of educational readjustment, rather than in terms of teeth extractions or tonsillectomy. That is to say, one must avoid the pitfalls of false analogies.

In treating pulmonary tuberculosis we have learned not to bother with localized pathology. We have learned to trust the wisdom of the body, assuming only the task of providing conditions favorable for the exercise of this wisdom. There is evidence of the existence of a corresponding wisdom of the mind. In my opinion we shall make no progress in dealing with either incipient mental maladjustments or incipient delinquency until we learn to utilize and to trust this wisdom of the mind, and until we learn how to provide favorable conditions for the exercise of it.

The assumption of the existence in the mind of *sui generis* modes of defense does not imply a dualistic separation of mental and physical life process. Modern psychology is far from insisting upon such a dichotomy. White, in his book, The Meaning of Disease, speaking from the standpoint of psychiatry, takes a position which is quite in harmony with prevailing trends in current psychological thought. He says (pp. 175-176) that

> "the oneness of body and mind, the organism-as-a-whole concept, and the interrelations between the organism and its environment, particularly the social environment, constitute an irreducible minimum of considerations that must be borne in mind if we are to arrive at any comprehension of the patient and his illness."

"Disease," says Dr. White (*Ibid.,* p. 197), "looked at from any angle we will, whether we view it as failure of adaptation or adjustment to

environment, whether as failure to measure up to internal standards of conduct-ego-ideals, whether it represents an inadequate integration of the individual as a social unit, however we may view it, it presents itself as inadequacy of some sort. This inadequacy may be organic inadequacy, mind inadequacy, social inadequacy, but inadequacy it seems always to be."

Speaking from the standpoint of psychology a recent writer, E. Brunswik,[3] says that

"Psychology deals with the abilities of organisms to establish intercourse in a successful way with the surrounding world, in reception (cognition) as well as in action."

This conception of psychology and of the adaptive rôle of mental functions does away with the necessity for a dualistic separation of mental and bodily processes, and at the same time makes unnecessary the resort to analogy for purposes of explanation.

The defensive devices of the mind are *sui generis* only in the sense that the character of each defense reaction must grow out of the nature of the defending organism as well as out of the situation or conditions against which the defenses are being set up. Coagulation of the blood, for example, is, as Cannon points out, a form of defense of one kind of organism against a particular kind of injury. Rationalization is another form of defense of a different sort of organism against a different sort of injury. Rationalization is another form of a different sort of organism against a different sort of injury.

Psychology is far from being able at this time to present so impressive a bulk of precise knowledge concerning the wisdom of the mind as Cannon has presented concerning the wisdom of the body. But such knowledge is by no means lacking. It will be in order here briefly to describe illustrative instances of mental defenses. And since we have chosen Freud to exemplify the use as well as the misuse of analogy in psychological thinking, we may mention first the defense reaction with which his name is most closely associated, namely, repression.

MENTAL DEFENSE THROUGH REPRESSION

"The theory of repression," says Freud, "is the main pillar upon which rests the edifice of psychoanalysis." Like so many others who have invaded the field of psychology from without, Freud attempted to build a whole system around one central idea, and, as we have noted, he constructed a complicated and scientifically questionable set of hypotheses to sustain that system.

But to let the fallacies of the Freudian system blind us to the facts to which he has drawn our attention would be unworthy of the spirit of scientific inquiry. Whatever Freud may have done with the idea, he was not the first to disclose the fact of repression. That living, sentient organisms react negatively to, or withdraw from painful stimuli is not a recent discovery. Since pain is itself associated with injury, it too must be interpreted as a protective device developed in the course of evolution by reason of its relation to survival. The simplest form of avoidance reaction is a spatial separation of the organism from a painful stimulation. This sort of behavior is noted far down in the phyletic scale.

Now, there are mental as well as physical pains and injuries. What can those creatures who are capable of *this* sort of pain do to safeguard themselves from the injuries incident to such experiences? Painful experiences, or traumatic episodes, as Freud designates them, turn into painful memories. Obviously one cannot separate oneself spatially from one's memories, and the memories of some experiences that befall human beings are so poignant that to make adequate adjustments to them is a matter of life and death. What defense is furnished here? Repression is Freud's answer to this query. "Repression," says Freud[4] . . . . "is the process by which a mental act capable of becoming conscious . . . . is made unconscious and forced back into the unconscious system."

Orthodox psychology is apt to think of repression not as an esoteric phenomenon nor as the only relief for the mind in the presence of uncomfortable ideas, but as being of one piece with other more familiar reactions which organisms of all sorts exhibit in relation to their environing conditions. One would naturally think of perception as a more stable process than memory, one less amenable to subjective control. Yet even perceptual processes, as well as those of thinking, have been shown to be affected by determining tendencies and organic sets of the mind itself. There are none so blind as those who refuse to see. If in strabismus the impressions from one eye continue to be disregarded, the eye that is disregarded tends to lose its sensitivity. Is it a strange, or even a different thing, if the mind loses sensitivity to its memories after having persistently excluded them from the field of attention? What becomes of memories thus disposed of is another story. We may not agree with Freud concerning this. But, that the mind has the wisdom, shall we say, to shield itself from their poignancy is the important point.

MENTAL DEFENSE THROUGH DISSOCIATION

According to Janet the organism which cannot cope successfully with its environing conditions will undergo dissociation or fragmentation. He is inclined to give more than the usual weight of importance to predisposing causes, such as general weakness of psychic synthesis, or the inherent lack of nervous energy necessary for the maintenance of functional tonicity. The characteristic pathology of hysteria, concerning which he developed his theory, is summed up under the general notion of restriction of the field of consciousness. This may show itself in somnambulisms, hypersuggestibility, absent-mindedness, etc. The physical symptoms are multiform, but, especially in the case of anesthesias and paralyses, they generally exhibit anatomical inconsistencies. Anesthesia of the hand from the wrist downward, for example, is inconsistent with the distribution of the brachial nerves. Blindness of one eye, without peripheral causes, is hardly consistent with the distribution of the optic nerves. These symptoms, says Janet, seem to correspond to the patient's *idea* of a hand or an eye rather than to the actual organic structures.

That such conditions are of central rather than of peripheral origin seems to be borne out by the fact that in the midst of treatment the symptoms being dealt with may shift from one side of the body to the homologous organ on the other side. One of Janet's patients, who had been successfully treated for a contractured arm, returned in two weeks with the other arm in the same condition.

This looks like sheer pathology, you say. For an organism to go to pieces in dealing with its problems does not, on the surface of things, promise success or indicate wisdom. But we should recall that we saw some wisdom in repression as a means of avoiding the full glare of pathogenic memories. To Freud this process of avoidance is an act of repression, of driving out, or down. To Janet it is an act of screening off, of pruning, of losing some to save the rest. Janet's conception of an hysterical patient is that of a man with an armful of bundles, more than he can carry. He drops one, and when he stoops to pick this up, he drops another. Here we see organic inadequacy again. But it is to be noted that only some, not all, of the bundles are dropped. Wise, is it not, to choose a half loaf in preference to none?

MENTAL DEFENSE THROUGH COMPENSATION

There is such a form of defense as compensation for experiences of inferiority. Adler, with whose name this adjustment device is associated, had in the course of his experience as a physician noted many instances in which the body compensated for organic deficiencies. If one kidney is excised, the other will develop so as to make up for the loss. The heart muscles will become strengthened so as to compensate for valvular leakage. The mental analogs of these adjustments constitute the basis of Adler's general point of view in psychiatry. The system of Adler like that of Freud is a dynamic system, but the dynamism in the Adlerian system is the desire for power. There is an urge within us not merely to exist but to live, to be God-like as he sometimes expresses it. The dynamism underlying the Freudian system as everyone knows is or was until the World War when other conflicts besides those of sex were found to bring a harvest of neuroses the libido or sex urge.

Children are oppressed, says Adler, by the superiority of the grown-up world into which they are born. The "compensative-formations" by which they face this awsome world are numerous. In some instances they will resort to modes of behavior calculated to provoke assurances upon the part of their social environment of a satisfactory status. In other instances they attempt to achieve such a status by self-assertion or the "masculine protest." In still other instances compensations may be sought through dreams, daydreams, and fancies. It is these fancies that give universal appeal to stories of the Beggar Maid and the Prince, Cinderella, Jack the Giant Killer, and all similar fancies in the literature and drama of the world, whether addressed to the juvenile or to the adult mind.

Successful adjustments are not always made. Unsuccessful efforts at compensation may terminate in degeneration. Partially successful compensations are calculated to result in neuroses or delinquencies. Over-compensation he believes is the source of genius. Contrary to accepted opinion he seems to think that all minds have peculiar abilities of some sort, if only they could be discovered and called out. However, there is no lack of instances of genius appearing as a sequel to desperate attempts to overcome handicaps. Examples are too numerous to need recital.

I am not sure but that in Adler's mechanism of compensation we have a phenomenon which may be subsumed under what is described by Cannon as homeostasis.

If homeostasis may be interpreted broadly enough to apply to social status as well as bodily temperature we may extend its meaning so as to explain the positiveness and the energy of our reactions against personal insults, which are calculated to disturb that status. If perception and cognition are to be included among the mind's modes of adjustment to its environment, we should discover some sort of homeostatic regulation even here. And so we do. It is known, however, in experimental psychology as constancy of perception. Snow that seems white in the sunlight also seems white in the moonlight, although sunlight is 800,000 times as bright as full-moonlight. A coin brought from a distance of ten feet toward the eye is not perceived as changing its size, in spite of the change of the size of the retinal image. That perceptual homeostasis such as this is related to successful adjustment is not difficult to imagine.

MENTAL DEFENSE THROUGH REGRESSION

The factors which determine the specific forms of defensive reactions which any organism will take under a given set of circumstances can scarcely be ascertained. Certain living organisms facing certain circumstances with which they cannot cope will regress to and function on lower levels of development for the time being. Records of human beings who have regressed, through severe emotional shock, to infancy, with the loss of all adult powers of understanding and speech, are not wanting.[5]

It is not necessary here to describe this phenomenon in detail, nor to list the wide variety of ways in which it manifests itself in human behavior. It is sufficient for our purposes to show grounds for considering it to be a mode of organic defense. The principle in accordance with which it may be so judged is, I believe, quite simply illustrated in the case of the planarian or flat worm. If this animal at a certain stage of its growth is cut in two, the cells, which may have reached a considerable degree of differentiation, will lose this differentiation and regress to an earlier embryonic stage, whence it will move forward again on a new program of differentiation and thus develop into two or more animals instead of one. Here, clearly, regression by dedifferentiation is the first step toward recovery.

In regression, as in other forms of involution or degeneration, the order of sequence is opposite to that of evolution or development. Hence, in any situation calculated to produce regression in human beings, the higher and more recently developed brain centers will become affected first, and so on in order. If a human being finds that he cannot face a situation on a high level of behavior he tends to drop to a lower one, like an army forced to abandon its front-line trenches in strategic retreat. This, according to Patrick,[6] is the meaning of relaxation. In sleep, he says, the human body must regress from its more recently acquired erect posture to the older supine position. The drug addict cannot face the responsibilities and discomforts of his life in a normal way, nor is he willing to pay the price the gods have placed upon happiness. So he must render his higher brain centers insensitive to the actualities of his existence and induce in himself the illusion of well-being by induced regression.

Regression, therefore, on its mental side, is a definite psychic act of retreating from the normal, adult adaptations of life back into the stages of infantile

security and comfort. Hence, the neurotic person is very likely to lose his capacity for and interest in high-level types of existence, and may load himself down with new symptoms, so that his remedy becomes worse than his disease.

MENTAL DEFENSE BY ESCAPE

Escape is a descriptive term of broad connotations. What we have previously noted regarding the use of drugs may be listed under escape reactions. Yet it seems necessary to list this form of behavior as a special category. It presupposes the typical condition of an organism facing a situation with which it cannot cope successfully. Retreat in some form is inevitable. Bodily flight, or fugue, with amnesia for the past, may be the form the escape reaction will take. One may become an ardent advocate of economic and political utopias and thus turn his mind away from what is to what should be, or one may take flight by imagination into islands of romance. Day-dreams and fantasies are at once a beneficent relief from harsh actualities and a danger to normal adjustments, for they seem to differ only in degree from the delusions of the psychotic. "Delusion," says Campbell, "is no foreign parasite battening on the mind." It is, says he, "an attempt of the personality to deal with special difficulties." In the story, "Mary, Mary," by James Stephens, adults deliberately indulged themselves in fancies to compensate for poverty. Queen Victoria indulged herself for forty years in the fancy that the Prince Consort was not dead, and should have his clothes laid out each day.

Already we are being told that there is such a thing as mental allergy. In addition to becoming allergic to pollens and foods, a man may become allergic to his job, his mother-in-law, or his lot in life, and the symptoms in the one case are as real and as distressing as in the other. Introversion is but the defense reaction of a sensitive mind against rebuffs and harsh actualities. Being able neither to alter nor to face outer realities, such a mind may seek relief by retreating within the sanctum of its own enclosures, where it may build a world more to its liking.

There are many other well-known types of defense reactions resorted to by the human mental organism in its efforts to adjust itself to the environing conditions to which it is exposed. But these will suffice to illustrate what is here meant by the wisdom of the mind. The further study and understanding of these modes of behavior is of incalculable importance. When we come to understand that many of the familiar symptoms of mental disturbances as well as of crime are but unsuccessful defenses against a hostile environment, we shall have gone a long way toward understanding many now mysterious human problems and toward forestalling disasters now growing out of our ignorance.

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THE INHERITANCE OF EMOTIONALITY*

CALVIN S. HALL
Western Reserve University

The proposition that individuals differ in all aspects of conduct is universally accepted by psychologists, and the investigation of the causation of individual differences in various psychological traits is one of the more popular problems of contemporary psychology. Witness the interest in intelligence testing. People vary in temperamental traits, for example, the degree to which they become agitated and stirred up by emotional stimuli, as well as in intellectual abilities. It should be possible, therefore, to measure variations in this trait, emotionality, and ascertain by experiment and correlation the underlying causes for the differences found.

The importance of such investigations should be evident to those who recognize the major rôle that emotion plays in conduct, especially that conduct deviating from the normal. Emotional instability is believed to be a major symptom if not the principal cause of nervous conditions and functional disorders. If we are to control and modify abnormal behavior, extensive knowledge concerning the bases for temperamental differences is required. Why does one child have a temper tantrum when in the same situation another child remains composed? Why does a business reversal cause one man to undergo a nervous breakdown, while for another it is a stimulus to subsequent business success? Why does Miss Jones embarrass her instructor with an hysterical outbreak as a consequence of receiving a poor grade, whereas Miss Smith accepts failure all too philosophically? These are questions concerning the why of temperamental differences among people. They are important questions and ones which psychologists have left largely to the unprofitable speculation of pseudo- and anti-scientific psychologists. The human desire to cast out those ubiquitous trouble-makers, "nervousness," "worry," "fear," and "melancholia" is so strong that any crackpot system which promises to do just that is eagerly taken up by the maladjusted. It does little good for those of us who consider ourselves respectably scientific to condemn charlatans when we have no worthy substitute for charlantry.

There are two major explanations usually given for differences in emotionality—the conditioning or learning theory and the hereditary predisposition theory. (We often have theories about phenomena concerning which we know little. It is unfortunate that a theory may be regarded as a fact by the uncritical.) An extreme proponent of the conditioning theory, for instance, the noted behaviorist, John B. Watson, believes that disparity in the frequency and strength of emotional reactions results from environmental influences encountered early in life. It is a fact that infants react emotionally to overstimulation, for example, loud noises, physical restraint and loss of support. These are as native and inborn as the sucking reflex or sneezing. All infants manifest them without variation according to the learning theorist. Individual differences in emotional behavior develop as a result of disparity in the amount of emotional

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conditioning established. A child exposed to frequent overstimulation develops greater excitability because certain other non-emotional stimuli acting on him at the time of his agitation tend on their recurrence to evoke emotional behavior, even though the original cause of the excited condition is then absent. In other words, all sorts of substitute stimuli gain the power to arouse emotion as a result of previous experiences. The harmless snake becomes a symbol of terror to the child who is present when his mother screams at the sight of a snake. The rabbit comes to arouse fear in the very young infant when a loud noise is made at the same time that the rabbit is presented to the baby. These are easily demonstrable facts and any observant parent can prove to his own satisfaction what John B. Watson spent months investigating at Johns Hopkins University.

We do indeed learn our fears, our hates, our angers, yes, even our loves. One person is afraid of moths, another of sharp-pointed objects, another of crossing the street, another of dirt, another of open spaces, another of closed spaces. A few rare souls are practically fearless. Others are relentlessly tormented by dread. And that is exactly the point in question. Why do some have so many, others so few fears, angers, hates and loves? Is it because of differences in the mere number of emotional situations encountered by people? Another hypothesis suggests itself. May it not be that we are born with dissimilar susceptibilities to emotional conditioning? Admitted that we learn to react emotionally to concrete situations, still may not the fact that one person learns to react emotionally to many more stimuli than another, be due to inborn differences? We do not know. I predict, however, that affirmative answers will be found to these questions.

The extreme proponent of the heredity side of this issue ascribes all temperamental disparity to differences in the germ plasm. The important genetic factors are very likely those which influence development of the nervous system, particularly the autonomic system and the thalamus, and the endocrine glands, since these are the organs most intimately related to emotional reactions. Although it is apparent that differences do exist in these bodily structures and in their functioning, it is not clear on the one hand whether the structure and function of these various organs are entirely a result of genetic determination or, on the other hand, whether individual differences in visceral structures are correlated with variation in emotionality. Our ignorance regarding the inheritance of temperament is even more profound than that pertaining to its modification.

It was in order to gain some fundamental knowledge concerning the causes of individual differences in emotionality that the present program of research was initiated. The first question to be settled was this: Is it possible by selective breeding to obtain two strains of animals, one an emotional strain, the other relatively unemotional and phlegmatic? Man is, unfortunately, not available for assortive mating experiments. Consequently, we must inflict our controlled matings upon a more docile species. For these experiments we have used that most convenient of laboratory animals, *rattus Norvegicus*—the rat. If two such strains could be obtained it would of course demonstrate that individual differences in emotionality are inheritable. Such an outcome would not, however, exclude the importance of learning as a determiner of differences

in emotionality, for conditioning might very well either accentuate or minimize the native dissimilarities.

This investigation is not the first to make use of the selective breeding technique for psychological purposes. Dr. R. C. Tryon of the University of California has selectively bred two strains of rats for maze-learning ability. The maze is for the rat what the Stanford Binet is for the child. One can therefore speak of his two groups as geniuses and morons or high IQ and low IQ. After nine generations of breeding Dr. Tryon has obtained two widely differing strains. It is anticipated that by a comparative study of these two groups the factors underlying intelligence may be more readily exposed. You may question, of course, whether rat intelligence is the same as human intelligence, but if you do put the question you are really not an evolutionist, and therefore your views deserve little serious consideration.

Dr. Rundquist of the University of Minnesota has selectively bred active and inactive strains of rats, and Dr. C. P. Stone at Stanford University has obtained early maturing rats and later maturing rats by this method.

Undoubtedly as time goes on an increasing number of psychologists will find the selective breeding technique useful in the investigation of psychologically important traits. Its value, apart from genetic analysis, is that it yields extreme manifestations of the trait in question. Hence the differences, magnified and exaggerated, can be more easily analyzed.

Although we recognize that individuals differ in emotionality, there are no very valid or objective emotional tests such as we possess for measuring intelligence, mechanical proficiency and musical abilities. Many physiological and biochemical changes associated with and resulting from purported emotional stimulation have been observed and much behavior reputed to be emotional in nature has been recognized and classified. In recent years questionnaires which presume to diagnose emotional instability have flooded the psychological literature. None of these physiological and psychological samples of emotionality constitutes, however, a suitable yardstick for measuring the relative intensity of agitation displayed by individuals.

After much experimentation we have discovered two valid, reliable and extremely objective measures of individual differences in emotional instability. Their use has been limited as yet to the rat but they could doubtless be adapted for other animals. Their value in human investigations is questionable. The measures are persistence of defecation and persistence of urination during successive exposures to an originally strange and novel situation. The exact procedure used will be considered later.

It is of course absurd to consider all voiding reactions emotional in character. But it has long been recognized that these responses may be precipitated by terrifying situations. Dr. Alverez, the authority on emotional indigestion, states that the earliest reference to the purging effects of fear and anxiety are found in an eyewitness account of a battle between two young kings of Persia. The historical account reads thus: "The vehemence of my battle line like a bow overwhelmed them. To save their lives they trampled over the bodies of their soldiers and fled. Like young captured birds they lost courage. With their urine they defiled their chariots and let fall their excrements." It is commonly known that the World War originated its full share of anecdotes

centering around the cathartic action of strong emotion. Love, as well as fear, may release the emptying reflexes. Alverez recounts that a young woman consulted him about an infirmity which threatened to interfere with her ever finding a mate. He writes: "In her the slightest sign of affection on the part of a young man so increased the tone and activity of the digestive tract that she was promptly summoned by a call of nature so imperative that it could not be denied; she had to flee precipitately just when she would most like to have remained." Hamilton, in his classic study of marriage adjustment, reports that individuals subjected to rigorous questioning concerning their marital behavior repeatedly interrupted the interviews in order to go to the restroom. This behavior is even more common among the less inhibited lower animals. Koehler, in his book on the mentality of apes, tells how the sight of a teddy bear so frightened his chimpanzees that they were immediately and thoroughly purged.

Every investigator working with rats must surely have verified our observation that these animals defecate and urinate during rough handling or during the first days in a new apparatus. Yerkes and after him Stone have used these reactions as measures of wildness and savageness in the rat. I see no justification for labelling a rat which persistently defecates as either wild or savage. He is just an emotional animal. The use of these measures as indirect criteria of wildness and savageness is, however, probably justified, since the less docile and tame a rat is the more excited he will become under conditions of captivity and restraint. Neither of these investigators attempted to show that the emptying reflexes are valid tests of individual differences in excitability.

Further evidence that defecation and urination may be evoked by exciting conditions is obtained from Cannon's studies on the physiology of emotion. He has characterized the sacral autonomic as a group of mechanisms for emptying. It supplies fibers to the colon, rectum and bladder. The normal stimulus for the evacuation of these reservoirs is distension by accumulation of contents. But during intense emotional stimulation impulses may overflow from the sympathetic system into the sacral segment and result in a discharge of the contents of the colon and bladder. Defecation and urination are thus linked to that configuration of reactions set off by the activation of the sympathetic segment of the autonomic nervous system. Apparently these emptying reflexes accompanying strong emotion have no utility such as the responses normally resulting from activation of the sympathetic segment.

How can we differentiate between emotional and normal evacuation? The criterion I have used for identifying defecation and urination as emotional is the fact that they cease upon repetition of the situation which originally evoked them. The situation which will evoke this behavior is probably any strange one.

The exact device I have most often employed is a circular enclosure seven or eight feet in diameter, surrounded by a wall high enough to prevent the rat from escaping. The floor of the enclosure is smooth and there are no nooks and crannies in which the animal may hide. The rat is by nature a stereotropic or wall-following animal. He is also negatively phototropic, that is, he prefers darkness to light. Consequently he finds the open field situation mildly terrifying. We have proved without question that these responses disappear after a certain number of experiences in the enclosure. Moreover, we have evidence

that as these reactions disappear other behavior which represents increasing adjustment to the apparatus, for example the eating of food, makes an appearance.

That defecation and urination may be truly emotional responses is indicated, therefore, by four lines of evidence: (1) they occur in situations recognized to be emotionally arousing in character, (2) they are linked with other reactions set off by impulses travelling over the autonomic nervous system, (3) they disappear as the originally strange situation becomes familiar, and (4) as the number of animals defecating and urinating decreases, the number of animals eating increases. However, this evidence does not prove that defecation and urination are valid measures of *individual differences* in emotionality. It is quite possible that group averages might not hold for individual cases, and that a rat which never voided during the period of observation was actually more upset than a rat which did defecate or urinate on one or more occasions. In fact, Alverez has proposed a theory that diarrhea is caused by mild excitement, constipation by more serious emotional stimulation. If this hypothesis should hold for animals other than man, then it might be said that rats which never defecated in the field situation were constipated and hence more emotionally upset than the easily purged animals. According to this hypothesis, two modes or peaks of emotional intensity would be expected, one occurring at zero defecations and urinations, and one occurring at the maximum number of defecations and urinations. Our initial task was, therefore, to validate these excretory reactions as tests of individual differences in emotionality.

A measure possesses validity if it actually measures that which it is said to measure. The expressions "validity" and "to validate" may be unfamiliar to some of you, although I am sure you are all acquainted with the concept to which those expressions refer. I may clarify its meaning by an example. The Wassermann test is recognized to be a valuable and convenient test of the presence or absence of syphilitic infection. We would say it was a very valid test. Its validity was established by demonstrating that a positive Wassermann was related to other more direct but less conveniently measured diagnostic signs of syphilis, and that a negative Wassermann was not so related to these symptoms. Its validity is not, however, perfect because occasionally a person giving a negative Wassermann does have syphilis.

In the present case we had to clearly demonstrate that variation in the persistence of defecation and urination was intimately related to variation in other manifestations of excitability. The problem of finding another measure of individual differences in emotionality was not easy and was finally solved by the following reasoning. It is a commonplace that emotional excitement may hinder the adjustment of the animal. For example, it may be an obstacle to the satisfaction of such a need as hunger. Hence it was argued that if a rat which ate in its usual living cage immediately upon the presentation of food, was placed in a strange enclosure, where food was readily obtainable, its failure to eat would be due to the excited state of the animal. The number of trials required before food was eaten in the enclosure could be taken as a measure of the rat's emotionality. Variation in this measure was used, therefore, as the second measure of emotional intensity against which to validate defecation and urination.

I cannot take the time to report in detail the results of the many experiments we performed to establish the validity of these measures. The general conclusion can be stated that defecation and urination are as valid, if not more valid, than most tests used in psychology. There is quite a sizeable relationship between the adjustment of the animal to the field situation as measured by the emptying reflexes and its adjustment as measured by food-eating. For example, animals that did not defecate on any trial in the field commenced to eat in the field on the second or third daily trial. Animals which evacuated on one or more occasions but less than ten (the total number of possible occasions) began to eat on the fifth or sixth day. Whereas those animals that voided every day in the field for ten days never did eat within the limits of the experiment.

Incidentally, these results do not confirm the theory of Alverez mentioned above. If constipation is a consequence of more intense emotional stimulation than diarrhea then we should expect those animals which did not defecate in the field situation to make a very poor adjustment to the eating of food. The zero defecating animals, however, were the best adjusted of all the rats as measured by our criterion. It is quite true that in man constipation often is a symptom of emotional maladjustment. It is my hunch, however, that this is a strictly human condition and results from man's ability to gain control over his sphincters. The natural response of the sphincters to emotional stimulation is dilation. Man has, however, found the consequences of impulsive dilation socially inept and disapproved. Hence he learns to avoid disastrous consequences by exercising "will power." He may, however, become so strongly inhibited that voiding under socially approved circumstances is made difficult. Thus, constipation.

We come now to the proper subject matter of this paper, the inheritance of emotionality.

The P_1 or parental generation consisted of 145 animals, 60 males and 85 females. These animals were obtained from various colonies maintained at the University of California by the department of psychology, the department of household science and the Institute of Experimental Biology, and from a colony maintained by the nutrition department at Oregon State College. The P_1 generation, therefore, was a very heterogenous sample of the rat population on the Pacific coast.

The animals were tested for their emotionality in the field situation as described above. The enclosure was seven feet in diameter, with a solid tin wall two feet high. The floor of the field consisted of battleship linoleum. The linoleum was washed after removing the animal in order to prevent the accumulation of odors. A daily trial consisted of two minutes and the records taken were presence or absence of defecation and urination during that time.

The distribution of the number of days during which the rats either defecated or urinated ranged from none to twelve. Seven of the most emotional males and seven of the most emotional females were mated. Likewise seven of the least emotional males and females were mated. From these matings there resulted seventy-five offspring. Forty of these were the offspring of emotional parents, thirty-five were the offspring of relatively non-emotional parents. At the age of three months these animals were tested for their emotionality

according to the same schedule as that imposed upon the P_1 generation. The results of the tests on the F_1 generation are striking. There were 139 occurrences of emotional defecation or urination. Of these 139 occurrences, 123, or 88 percent, of the total were made by the progeny of emotional parents, although these offspring constituted but 53 percent of the F_1 generation. Only 15 of the 139 occurrences or 12 percent were contributed by the progeny of the least emotional P_1 rats.

The results may be presented in another way. The male offspring of the emotional rats defecated or urinated on the average approximately four days out of the total twelve daily trials in the field. In contrast, the male offspring of the non-emotional P_1 rats averaged less than one day when excretory reactions occurred. The differences between these two averages is 3.2 and according to a rigorous statistical criterion it is quite unlikely that this difference could be due to a sampling error. Similar differences in the emotional measures for the female rats were found. The female offspring of emotional animals averaged 2.4 days during which defecation or urination occurred, whereas the progeny of non-emotional rats averaged .07 days when emotional responses were elicited. This difference of 2.3 is also a true difference and not a chance one. Combining the results of both males and females, it may be said that the offspring of the most emotional rats were nearly seven times more emotional than the offspring of the least emotional rats. The distribution curves for the two groups are shown in Figure 1. These preliminary results unquestionably indicate that two strains of rats markedly different in the frequency of emotional behavior can be produced by assortative mating. Differences in emotionality appear to be genetically determined.

It is hoped that as a result of successfully breeding an emotionally stable, well-adjusted race of rats and an emotionally unstable, neurotic strain of rats, fruitful experiments on the basic causes of emotional instability will be facilitated. We hope to learn just how neurotic rats differ from the more stable ones. Are there, for example, significant anatomical differences? Is there noticeable variation in the structure and function of the various endocrine glands? Are there dissimilarities between the strains with respect to other organs of the body? Will biochemical analyses yield any clues as to the why and wherefore of emotionality? Will neurological differences appear? It must be apparent that for these studies we will need much assistance from other biological scientists.

As a psychologist, I am primarily interested in the relationship of emotional instability to other aspects of behavior. Does the emotional animal, for example, learn with less efficiency than the non-emotional, that is, do emotional instability and feeblemindedness go together? We already have gathered some data on this point and the results so far indicate that the emotional animal is not handicapped in a learning situation. In conversation, however, with another investigator, Dr. E. E. Anderson of Harvard University, who has used our method of measuring emotional instability, he informs me that there is a small but significant relationship between emotionality and learning. The disrupted rats are slightly inferior in habit formation.

Is there any correlation between age and excitability, and if so, is it negative or positive? Preliminary results indicate that young rats are less emotional

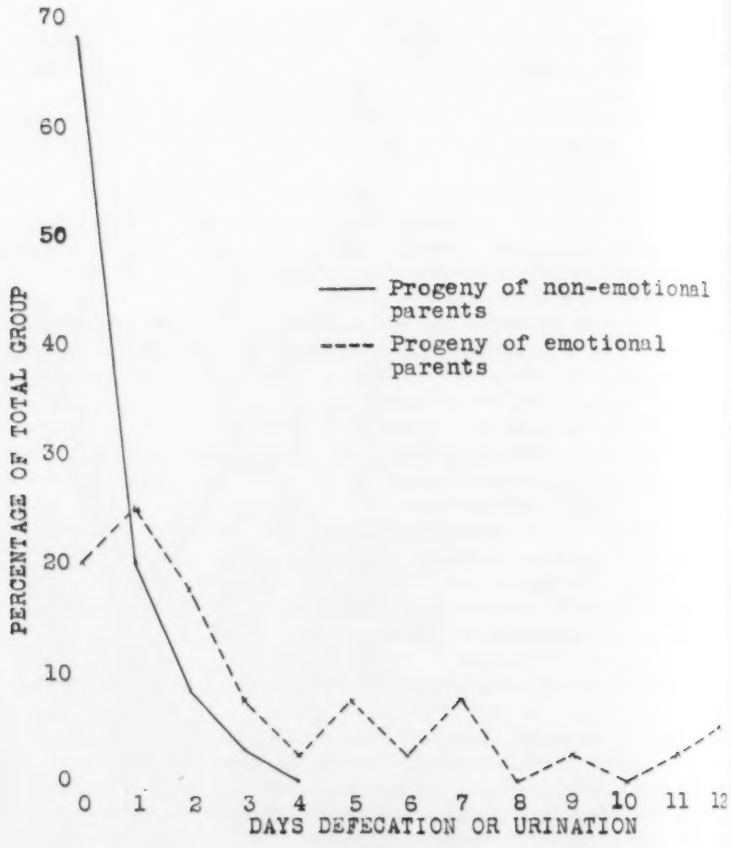


FIGURE 1

than old ones. This may be due to the kind of living quarters provided for laboratory rats. They are kept in rather small cages and it might be expected that sudden exposure to an open field would be more of an emotional shock to staid old animals, accustomed to a set routine, than to young ones whose habits had not become so fixed.

Are there sex differences in emotionality? Rather extensive results indicate that the male is more emotional than the female. We do not even have a working hypothesis as to why this should be true, and I hesitate to state the bald fact in view of the conventional belief that females are more susceptible to fear-arousing stimuli. One convenience of using the lower animals as subjects for psychological experiments is the fact that they do not have culture patterns. Little girl rats grow up quite naturally without being admonished by their

parents to act as little girls should. And thus growing up naturally these girl rats apparently develop greater stability in the face of danger than do their brothers. Or perhaps rat society is dominated by the weaker sex, and the males, as a result, are the ones who develop neuroses.

The relationship between emotionality and overt activity has been ascertained. Emotional rats are definitely less active than non-emotional ones. This suggests that caution is quite a primitive biological behavior pattern. We know, of course, that many animals go into a death feint when danger threatens. It is interesting to consider the inverse relationship between emotionality and activity with reference to the adjustment of the animal. You are all doubtless familiar with Cannon's emergency theory of the emotions, which states that the emotional pattern, consisting of a release of blood sugar, the conteraction of fatigue, a shift of blood volume to the peripheral muscles, increased activity of the heart, more rapid respiration and other changes, prepares the animal for either fight or flight. The freezing up behavior noted in excited rats does not appear on first thought to conform to this theory. It is quite likely, however, that a tense, crouching animal is more ready to flee when and if danger should strike. His cessation of activity is a preparation for danger which lurks in a strange environment. We cannot really know whether agitation will aid or hinder adjustment unless the total situation is considered. The student angered and frustrated by a difficult test is prepared by his emotion to fling the offending exam in the face of the instructor. That action would hardly constitute a good adjustment. Suppose, for example, that two animals differing in emotionality are placed in a food-seeking situation, and further suppose that the food objects are scattered rather sparsely throughout the environment. In this situation the less active, more emotional rat will be handicapped in locating food by the fact that he gets around in the environment to a lesser degree than the more active, non-emotional animal. Emotionality in this situation will prolong maladjustment. Consider an analogous situation in human behavior. We can predict that a timid, fearful person may fail to make an adequate adjustment because of the caution which accompanies his fear. He will be less likely to entertain novel ideas or undertake new ventures and thereby fail to improve his status. On the other hand he will avoid the maladjustments which often ensue from lack of caution.

Another behavior pattern which differentiates the stable animal from the unstable one is that of stereotyping. By stereotyping is meant the persistence of the same response in a free-choice situation. A person is said to manifest stereotyped behavior whenever he performs the same act or series of acts in a situation where alternative responses are possible. The individual who always walks home by the same route, the professor who repeats the same lecture year after year, the child who says a nursery rhyme over and over again are all manifesting stereotyped behavior.

In order to test for stereotyping in our animals the following situation was devised. The animals were introduced into a small ante-chamber from which they could go by five equidistant routes to food. All five pathways were identical in every respect except that they radiated off from the ante-chamber at different angles. The subjects were given fifty choices in this situation, five trials a day for ten days.

The emotional animals proved to be less stereotyped in their behavior than the phlegmatic rats. In other words, their fifty choices showed a greater variability over the five possible pathways than did the choices of the non-emotional animals. This is not an unexpected result. Highly excitable people are commonly characterized as "flighty" and the typical manic is extremely variable in his reactions. It is this unpredictability of the manic's behavior which makes him eligible for institutional care.

Another investigator found that animals which were given an electric shock became more fixated in a free-choice situation than did non-shocked rats. This observation would seem to contradict ours. A shock is, however, a different sort of stimulus than strangeness. A shock is something definite to be avoided by running away. And the most direct route away from the shock, psychologically speaking, is the same route which the animal took before. In our situation, the emotional stimuli come from no precise locus in space. They pervade the whole unfamiliar environment and are something which the animal cannot escape until it has eaten and been returned to its familiar living cage. Hence, the emotional animal behaves in an undirected manner because it is stimulation on all sides by regions to be avoided.

I have formulated a general hypothesis to explain these contradictory findings: If an emotional stimulus can be avoided immediately through directed activity, stereotyping of behavior will result; if an emotional stimulus cannot be avoided directly, variable behavior will occur.

I believe this hypothesis will help explain why some emotional situations are easily adjusted to and why others result in persistent maladjustment. Many of our fears and angers in everyday life persist because the stimuli for them are vague and impalpable. Fear of insecurity, fear of death, fear of unknown enemies, anger towards society—these are similar in their effects to the fear of strangeness manifested by our animals. A snake, a bear, a known enemy, fire, and electric shocks likewise evoke emotion, but the excitement is usually transient since the stimuli can be swiftly adjusted to with an appropriate reaction.

We hope that one of the major contributions of these studies on individual differences in emotionality will be in the field of psychotherapy. Granted that differences in excitability are due largely to heredity, the question then becomes one of what can be done to alleviate this inborn disposition. Psychologists recognize that human nature can be modified, although there is still much controversy as to the extent of modification which can be effected. Variation in general intelligence is attributed to heredity, but there are many authorities who believe that by environmental changes the intellectual level of a given person may be mardedly increased or decreased. Certainly there are remarkable instances of a striking change in IQ as a result of changed environment.

Can the EQ or emotionality quotient of a person be similarly modified? Certainly a person who is shielded from emotional stimulation will never become excited. Over-protection is, however, usually not recommended except in rare cases where other methods may fail. The world is not a cloistered place and sooner or later the sheltered person is almost bound to lose his protection. Hence, it is important to restrain the emotional individual so that he may be better prepared to adjust to the world as it is.

Various methods of retraining the emotions have been suggested. There is the method of elimination through disuse. This method is reputed to be quite ineffective. An emotional rat becomes no less emotional by interrupting his daily trials in the field situation. When he is returned to the field his excitement is even more pronounced.

A second method is verbal appeal. It cannot be used with animals, and for that matter it has little value in human readjustment.

Another method is that of negative adaptation, or getting used to a situation through repeated exposure to it. In the case of both humans and lower animals, this method is successful with some subjects. With others, the emotion is only intensified by repetition. In the case of rats, it works better with younger than with older animals.

A fourth method is that of repression through social ridicule and teasing. Animals do not react to teasing, except with more emotion. This substantiates what has been found with human subjects. Razzing may bring about an inhibition of open display of emotional behavior, but the emotion is usually more firmly entrenched within the individual. Repressed emotions are more serious than overtly expressed ones, because damming up an emotion intensfiies it.

Three other methods are mentioned in the literature: distraction, direct conditioning and social imitation. I believe that all three of these methods involve the same general principle. Diminution of emotion will result whenever the subject is trained to react to a non-emotional aspect of a fear-arousing situation. We have demonstrated that emotionality can be weakened if the animal is placed in the field hungry and food is easily obtainable in that situation. Eating and emotional behavior are incompatible responses and if the animal eats, his excitement is inhibited. Furthermore, this adjustment to the situation persists even though the animal is later placed in the field non-hungry. This observation illustrates the well-known psychological dictum "that the response which occurs is the response which will become associated with the situation." I have suggested that the presence of a need such as hunger will inhibit the display of emotional behavior by distracting the animal from the fear-provoking aspects of the situation, and conditioning him to the more pleasant features of the environment.

It is quite possible that in the foregoing situation the outcome will be the reverse, that is, a turbulent state may inhibit eating. With some of our rats this proved to be the case and had we not taken pity on the beasts at the last minute, they would have starved in the midst of plenty. The psychologist must be careful, therefore, to make sure that conditioning will not occur the wrong way round. It would be disastrous if we should become afraid of food by associating it with an emotional situation. Unfortunately this is too often done when the dinner table is made a clearing-house for heated arguments and irritating criticisms.

It will be interesting to try out all sorts of reputed therapeutic measures with our emotional strain of rats. Many drugs are reputed to have a beneficial effect upon neurotic behavior. Too often, though, the results are only temporary or due to suggestion rather than to the pharmaceutical properties of the drug. Fortunately, we do not have to contend with the attenuating factor,

(*Please turn to page 37*)

THE SETTING OF A GEL—PHYSIOLOGICAL IMPLICATIONS

CHARLES B. HURD

Union College

INTRODUCTION

The field of colloid chemistry, filled as it is with the unusual and the unexpected, probably contains no more strange phenomenon than the setting of a gel. It requires something more than a mere exercise of our imagination to believe that a silicic acid gel, which is a firm but moist elastic semi-solid, contains nothing but silica and water, particularly when it is recalled that silica is a hard crystalline solid. The biologists tell us that the human body contains many jelly-like structures, and we can see a fairly close resemblance between our laboratory product, the silicic acid gel, and such organs as the lens of the human eye and the cartilage at the end of a growing bone.

Biological science has a very difficult field for study, complicated as it is by the presence of very intricate organic compounds and by that unmeasurable influence called life. When a chemist wishes to study a complex reaction, he studies the problem in steps, isolating certain variables and keeping others constant. The biologist may be interested, therefore, in some of the facts which the chemist has found out concerning these apparently simple inorganic gels, and from these simplified conditions may draw valuable conclusions concerning the more complex jellies so important in the structure of living organisms.

It will perhaps be worth while for us to discuss briefly some of the information available concerning silicic acid gels, not only because such information is of great interest in the rapidly growing field of colloid chemistry, but also because from such a survey research workers in other fields may see the gleam of an idea pertinent to their own research. All of us, after all, are scientists, and although we have chosen to subdivide our field of science into separate fields, and to carry our specialization to the extreme, we have nevertheless a common ground for experimental method and often a surprising parallelism of ideas.

HISTORICAL SURVEY

As we begin our discussion, let us describe an experiment. A solution of sodium silicate is both clear and colorless. So also is a solution of acetic acid. If we pour the solution of sodium silicate into the acetic acid solution, choosing the correct concentrations and making sure that the acid is in excess, we shall see that nothing apparently has happened; the result is both clear and colorless. If the mixture is allowed to stand, a faint opalescence becomes visible. This opalescence increases and we are aware, suddenly, that the limpid solution has become viscous. The viscosity increases rapidly until the solution will no longer flow. The mixture has set. This result is a silicic acid gel, called sometimes in the literature a gel of hydrated silica.

Apparently the existence of this form of colloidal silica has been known for over one hundred years, since we find a reference by Walden[31] to the work of

Meyer and Bergmann before 1800, on solutions containing colloidal hydrated silica. An early reference to the silicic acid gel itself was given by Ebelmen,[2] while the work of Graham[7] is quoted by most books on physical chemistry. These early workers were apparently surprised to find a jelly-like substance composed of silica and water together with non-important impurities, a fact which still causes surprise. The early studies were devoted to the discovery of methods of preparation and an investigation of the gel properties.

Many of the recent investigations have been devoted more particularly to determining the conditions under which the gel is produced, and to attempts to discover data which would aid in forming a concept of the structure of this apparently simple inorganic gel. Various theories for the mechanism have been formulated and tested. Many attempts have been made to establish the existence of some definite chemical compounds of silica and water in the gel without result.

METHODS OF PREPARATION

Any method which will prepare a sol of hydrated silica may be used in the preparation of silicic acid gels. It requires a sufficient concentration of silica, something over one percent, to give the strength necessary to support the gel structure, but anything over two percent silica gives firm gels. The time of setting is a function of the silica concentration, the temperature and hydrogen ion concentration, to mention the most important influences. It may require some time for the gel to set, but generally speaking any sol of hydrated silica containing two or more percent silica will set eventually to a firm gel.

The reaction of a solution of sodium silicate with a solution of an acid is the commonest method for preparing the gel. Other methods include the hydrolysis of silicon tetrachloride,[21] of the fluoride,[3] the sulfide,[5] and of several of the esters of ortho silicic acid.[8]

By electrolysis of sodium silicate, Treadwell and Wieland[29] prepared very pure sols of hydrated silica and equally pure silicic acid gels. The purest gel, probably, was prepared by the oxidation of silane (SiH_4) in water by ozonized oxygen.[19]

Other miscellaneous methods have been employed, but those mentioned above are the more common. Each method gives a colloidal solution of hydrated silica from which the gel forms in time.

PROPERTIES OF SILICIC ACID GELS

The properties of a silicic acid gel which are immediately apparent are its firm, semi-solid, elastic character, the opalescent appearance and the fact that its formation occurs relatively rapidly following a period of induction. Other equally important characteristics are of more value in helping us form an opinion not only of the structure of the gel, but also of its mechanism of formation. Most gels have, apparently, a loose open structure so far as molecular sized particles are concerned. The gel structure appears to offer no measurable obstruction to the flow of ions through the gel, as indicated by the electrical resistance. A silicic acid gel exudes fluid for some time after its formation. the process being called syneresis. Although the opalescent appear-

ance is pronounced, the microscope has shown no definite structure in silicic acid gels. Other properties can best be indicated in the course of the discussion.

As the gel-forming solution is allowed to stand during the so-called induction period, various measurements will show very little change. The viscometer will show a very gradual change in the viscosity, a gradual increase which of course becomes very rapid as the gel sets, yet during the induction period less than 10 percent increase occurs. The surface tension of the solution also shows only a very slight rise.[15] No visible change occurs until the opalescence appears just before the setting. It would appear, then, that so far as gross physical properties are concerned, only very minor increases in viscosity, surface tension and opalescence have occurred. The electrical resistance will have remained constant.[18]

Measurements of properties within the range of molecular dimensions, however, show significant changes. When the sodium silicate and acid solutions are first mixed the molecular weight of the silicic acid formed is about 100. This has been ascertained by measurements of the depression of the freezing point.[1] This should indicate a molecule of a monosilicic acid such as ortho silicic acid (H_4SiO_4) or meta silicic acid (H_2SiO_3). It has also been found[23] that when first formed this silicic acid passes easily with the other crystalloids through a dialysis membrane. As the sol stands, the molecular weight has been found to rise rapidly, the measurements becoming inaccurate as the molecular weight passes into the thousands. Confirming this evidence is the fact that the silicic acid soon loses entirely its ability to pass through the dialysis membrane. It is apparent that a polymerization or condensation is taking place, giving rise to larger and larger molecules until the word molecule has lost its significance.

It is evident from these observations that the molecules or super molecules of the condensed silicic acid offer little impedance to the flow of the fluid. When they have increased to such a size that the large and rapidly growing clusters actually interfere with each other, the viscosity of the solution shows a rapid increase—in fact, this restriction to the free motion of the particles permits a tying up of the large particles into a relatively firm structure which we recognize as the gel. This restriction on the free motion of the particles appears to be a necessary stage in the setting of the gel.

An interesting observation may be made during the actual setting stage. The increase in the viscosity is only a part of the actual setting process. Shortly after the rapid increase of the viscosity has begun, it will be observed that the gel mixture is developing elasticity. This can be observed as follows. If a small, light cylinder is suspended in the solution, it may be rotated freely at first with no more impedance than would be observed in water. As the viscosity of the solution increases, more and more resistance is offered to the flow of the liquid and to the rotation of the cylinder. The only effect of this, of course, is to slow up the response of the cylinder in following a torque caused by rotation of the suspension.

The development of elasticity is characterized by the presence of a restoring force. The restoring force will cause the cylinder to reverse its slow rotation if the torque is released, and to move part of the way back toward its original position. In these soft gels the elasticity behaves somewhat as would an elastic band; a stretch occurs up to a limit beyond which the resistance is much greater,

and which is very close to the point at which the structure breaks. The whole phenomena acts as though a twisted or kinked structure under tension were being straightened out. Once straight, it resists strongly and then breaks. This is apparently exactly what does happen, on a sub-microscopic scale.

These forces, which develop in the gel to such an extent that the gel structure can remain firm and can enclose as much water as 97 to 98 percent of the weight of the whole gel, cause a gradual contraction of the structure once it has become firm. This contracting process has apparently been in progress for some time, but the effect becomes apparent only after the gel has set. Then the contraction forces out of the gel a small part of the fluid. This action is called syneresis. With some gels, syneresis is very pronounced, such as in sour milk. With silicic acid gels moderate syneresis occurs. The fluid consists of water or a solution of each of the salts present in the gel mixture. It has been studied carefully, for example, by Ferguson and Applebey.[4] The fluid comes out uniformly over the surface of the gel, indicating that it passes to the surface through the porous structure, somewhat as water would appear on the surface of a rubber bath sponge filled with water and subjected to slight pressure. The syneresis confirms both our idea of these contracting forces at work in the gel structure and the capillary nature of the structure itself.

Microscopic or even sub-microscopic examination of the silicic acid gel has failed to reveal any visible and definite structure. The presence of material of colloidal dimensions is demonstrated, naturally, by the opalescence. This property has been studied by Krishnamurti[20] and later by Prasad and his associates[27] who have used this property to determine the time of set. The scattering of the light by the gel mixture is negligible at first, then rises rapidly during the setting and reaches a value which remains essentially constant. The gel, of course, shows the Tyndall cone, which indicates particles of colloidal size capable of reflecting or scattering light.

It has proved to be a matter of surprise to those who have measured the electrical conductivity of gels to find that the electrical conductivity does not decrease markedly when the gel sets. As a matter of fact, we have been able to find less than 2 percent change in the conductivity.[18] This fact can probably have only one interpretation, which is that the gel possesses an open structure through which the ions flow without obstruction. Ions flow easily through the gel, and ionic reactions may be carried out in almost any gel although more work has been done on this effect in gelatine and in silicic acid gels.[10] The fact that ionic flow occurs but that there is no stirring, causes the reactions to take place very slowly. This condition makes for the growth of large crystals of the precipitate.

THE SETTING PROCESS

Although in the earlier studies of silicic acid gels the interest centered almost entirely in the preparation and more particularly in the properties of the gel, the more recent work has been chiefly concerned with the actual process of the setting of the gel. During the last ten years workers in various laboratories have collected enough data so that a reasonable

attempt may be made to formulate a theory to explain the setting mechanism.

Certain factors and conditions are known which affect the rate of set of a silicic acid gel. Among these are the concentration of silica, the temperature, the hydrogen ion concentration and the concentrations of various impurities, to mention only those conditions which have been most thoroughly studied.

The time of set of a silicic acid gel mixture is decreased with a rise of temperature.[23] As temperature rises, the rate of the setting reaction increases, regardless of what this reaction may be. A recent study of this effect[16] has shown that the process behaves toward a change of temperature as though the process were a chemical reaction. The energy of activation of the process has been found to be 17,100 calories.[12] This would cause us to believe in a chemical reaction rather than a mere coagulation of the colloidal material from the sol of hydrated silica.

It has long been recognized that the time of set is dependent upon the concentration of acid in the gel mixture.[23] More recently Holmes[9] has studied this relation carefully, finding a minimum time of set in the very slightly alkaline mixture, and finding that very acid gel mixtures also show a very short time of set. The optimum pH limits for setting mixtures were studied by Ray and Ganguly.[28] In a study conducted in this laboratory[17] it has been shown that in moderately acid gel mixtures, the time of set increases linearly with the hydrogen ion concentration. It is also noticeable that in basic gel mixtures the time of set appears to increase linearly with the hydroxyl ion concentration. These facts suggest the importance of hydrogen and hydroxyl ions in the setting process.

The effects of various impurities upon the time of set have been studied by many workers. As Hurd and Carver[13] have shown, however, great care must be exercised, since many impurities change the hydrogen ion concentration, thereby automatically changing the setting time. Various salts appear to decrease the time of set,[17] while organic compounds in general decrease the time of set[13, 24] The striking thing observed in all of these investigations was the relative insensitivity of the sol of hydrated silica to these foreign substances, suggesting that the setting process is not merely a coagulation of colloidal material, as has been suggested in one theory.

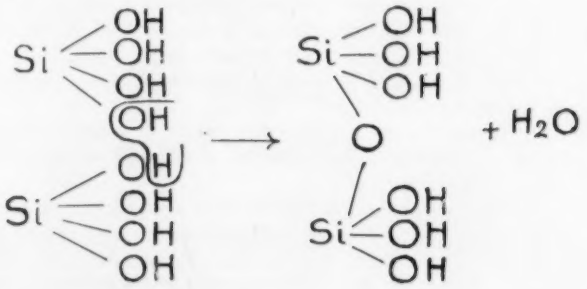
THEORIES FOR THE SETTING OF THE GEL

From the many papers which have appeared, giving the results of studies on the setting of typical gels or jellies, certain theories for the setting of these gels have been formulated. We should call attention here to the idea, frequently overlooked, that it is highly unlikely that all gels set by the same process of mechanism. The reader is referred to the papers of von Weimarn[20] and Ostwald[26] for a general discussion of the various theories of gel structure.

While all gels are characterized by the semi-solid structure and all contain a large amount of the fluid component, it is noticeable that they show sharp differences in many of their properties. Some are thermally reversible, such as gelatine or agar jelly—that is, they set upon cooling and are liquefied when heated. Silicic acid gel does not do this; a rise of

temperature merely hastens the setting reaction. Some gels are very sensitive to the hydrogen ion concentration, such as silicic acid gel. Some have a coarse structure, visible through the microscope. Some are liquefied by shaking and set again upon standing.

The theory held in favor by most workers for the inorganic gels is the Fibrillar or Micellar Theory. This assumes that the gel consists of a fibrous or fibrillar structure saturated with liquid. In the case of silicic acid gel, the fibrillar structure appears to consist of condensed silicic acid, the molecules having tremendously long and branched chains, interconnected and intergrown. This condensation takes place by the splitting off of water from two neighboring molecules of simple silicic acids, the condensation continuing between larger and larger molecules until the word molecule practically loses its significance. This is shown as follows, for the first stage:



A detailed consideration of this theory has been prepared and should appear soon, although sections of the work have been discussed[14] and the theory presented for a review.[11]

Any conditions which may affect this typical reaction may equally well affect the rate of setting of the gel. A rise in temperature may increase the degree of ionization of the amphoteric hydroxide of silicon, looking upon the condensation as the union of two ions, or it may bring about more frequent collisions by increasing the mobility of the ions. Both effects undoubtedly occur.

The chemist will note that this condensation may result from amphoteric silicon hydroxide giving both cations and anions containing silicon. These ions would then unite. It is difficult to demonstrate this amphoteric ability of the silicon hydroxide, but it appears reasonable from its position in the periodic table.

GENERAL DISCUSSION OF THE PROBLEM INVOLVED

The results of the various investigations of some of these properties of silicic acid gels suggest a number of valuable fields for study.

Although the effect of temperature upon the setting reaction in gelatine and agar jellies may not be studied, because of the thermal reversibility of the gel, the effect has been carefully studied in the silicic acid gels. The energy of activation has been mentioned. This probably represents the energy necessary

to activate the molecules which engage in the condensation reaction. Here is a slow, inorganic process which can be studied from the point of view of quantum mechanics.

The similarity of gelatine and silicic acid gels has often been noted. It is possible that both proceed by a condensation process, the amphoteric nature of gelatine being recognized and that of silicic acid being assumed. Such a process is believed to occur in some, at least, of the synthetic resins. The writer, several years ago, was able to discuss this reaction with a prominent research worker in the synthetic resin field, and was surprised to find the applicability of many of the ideas obtained in the study of silicic acid gels to the commercial process. The biologist and physiologist can find much of interest in this easily studied inorganic jelly.

The deposition of solid material in the form of a precipitate in artificial jellies gives often a banded structure similar to what is observed in some agates. This Liesegang Ring formation is easily accomplished in silicic acid gels, and has been carefully studied. Deposition of solid material in the gelatinous cartilage in the body gives hardness and strength to the bones. The physiologist is very anxious to know why certain vitamines promote this growth and the deposition of the solid material.

The effect of radiant energy upon the time of set of silicic acid gels should be studied carefully as should the effect of ultra sonic vibrations.[6] These two fields are relatively unexplored.

Recently the medical profession has become aroused to the dangers of silicosis. In some way which is not yet understood, the very fine silicious dust embedded in the lung tissue undergoes a change which has very harmful effects. It was shown by Lenher[22] that by heating very finely ground Ottawa sand with water under pressure he was able to hydrate the silica and to produce colloidal silica. Possibly in contact with the lung tissue for some time at body temperature, some of the silica may be hydrated and gel formation may result. When it is remembered that 3 percent silica in a silicic acid gel immobilizes 97 percent water, the possibility of the process is evident. Such an investigation might give very significant results.

In any field of science there is always much detailed information known only to the advanced worker. Much of this information is highly specific, but often also this specific information has unobserved connections to other fields of study. The writer feels this to be true in the study of silicic acid gels. Here is probably the simplest of the inorganic gels which is formed by a condensation reaction. Conditions for rigid control of the variables are certainly attainable. The process of setting may be and has been studied systematically. The old scientific principle of studying the simplest conditions under which a process may run and may be observed accurately is easily fulfilled here, far more easily than would be the case with some even of the least complex organic gels.

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SIGMA XI

HALF CENTURY RECORD AND HISTORY

Compiled by

HENRY BALDWIN WARD

and

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HARLOW SHAPLEY

Member of the Executive Committee
The Society of the Sigma Xi

HARLOW SHAPLEY

Professor Shapley needs no introduction to any group of scientists in any field of science anywhere in the world of science. He has been director of the Harvard Observatory since 1921, to which position he came from his work at the Mt. Wilson Observatory in California. He has been a lecturer in English and Belgian universities, and the Darwin lecturer of the Royal Astronomical Society. Many universities have recognized his unusual service to science by conferring upon him honorary degrees—among them Princeton, Harvard, Pittsburgh, Toronto, Brown. He is a member of the National Academy of Sciences, the American Philosophical Society, the National Research Council, and has been awarded many medals for the brilliant results of his astronomical observations. He has given Sigma Xi generously and helpfully of his time and broad acquaintance in science circles as a member of the Committee of Awards of the Sigma Xi Grants-in-aid. The Society welcomes him heartily to wider responsibility in the organization as a member of the Executive Committee.

The Inheritance of Emotionality

(*Concluded from page 27*)

suggestion, when working with animals. Suggestibility is one of the payments we humans make for being so much more modifiable than the lower animals.

In concluding this address, I should like to make a statement of faith. I was originally a rabid environmentalist. I thought that rather drastic changes could be made in human nature through proper manipulation of the environment. With this optimistic, Pollyannish, viewpoint I found myself in sympathetic rapport. As a novice in psychology, I imagined how satisfying it must be to mould human nature and thereby create a better world. Like any paranoid, I found it difficult to abandon this very comfortable delusion of grandeur.

In order to clearly state my present position, I will quote from the distinguished psychologist, Lashley. He writes: "One group, differing in other respects as widely as the behaviorists and the psychoanalysts, would have us believe that temperamental differences are wholly the result of childhood training and that uniform education beginning at birth would result in a uniform product. Other equally influential groups have minimized the environmental factors and have ascribed unlike temperaments to different hereditary endowments. The more conservative have asserted the existence of constitutional differences but assumed their ready modification under social pressures; the more radical have regarded the constitutional differences as inalterable and expressed a pessimistic attitude toward all efforts at social control."

I occupy a position somewhere between the conservative and the radical hereditarian. I believe in the importance of constitutional differences. I do not believe these differences are unalterable. On the other hand, I do not believe that they are readily modified by social control. I believe that individual differences in intelligence, temperament and character can be modified but not easily nor drastically. Finally, I believe that controlled breeding is man's most effective weapon against feeblemindedness, insanity, and psychopathic behavior.

MINUTES OF THE MEETING OF THE EXECUTIVE COMMITTEE OF SIGMA XI, INDIANAPOLIS, INDIANA, DECEMBER 28, 1937

The second meeting of the Executive Committee for 1937 was held in the Claypool Hotel, Indianapolis, Indiana, December 28, 1937, at 2.00 P.M. Present were: President Durand, Secretary Ellery, Treasurer Pegram, Professor Parker, Professor Stadler, Professor Gortner, Professor Lund, Mr. Sweet, and, by invitation, Professor Henry B. Ward, Professor George A. Baitsell and Professor K. M. Wiegand.

Business was transacted as follows:

1. FORMAL PETITIONS FOR CHARTERS FOR CHAPTERS.

It was

Voted: To present to the 38th annual convention, with recommendation to avorable action, printed petitions for charters for chapters from groups of the faculty at the following institutions:

a. Rice Institute.
b. Massachusetts State College.
c. Wellesley College.
d. University of Florida.

2. INFORMAL PETITIONS FOR CHARTERS FOR CHAPTERS.

a. University of West Virginia.

It was

Voted: To request the petitioning faculty group at the University of West Virginia to present a formal printed petition for a charter for a chapter for the consideration of the Executive Committee at its April (1938) meeting.

b. University of Southern California.
c. University of Alabama.
d. University of Georgia.
e. Virginia Polytechnic Institute.

It was

Voted: To make the informal petitions for charters for chapters at these four institutions a special order of business at the April (1938) meeting of the committee.

3. SIGMA XI CLUBS.

It was

Voted: To authorize the formation of Sigma Xi clubs at

a. Utah State Agricultural College.
b. Brigham Young University.

4. Officers' Reports.

a. Report of President.
b. Report of Secretary.
c. Report of Treasurer.

These reports appear in full in the printed minutes in this issue of the Quarterly, pages 47, 55, and 60.

Following the treasurer's report, it was

Voted: To present to the convention the following resolution with recommendation for favorable action:

Resolved: That the annual assessment on each chapter for 1938 shall be payable on January 1, 1938, and that the amount of the assessment on each chapter shall be 75¢ multiplied by the number of members and associates of the chapter on January 1, 1938.

Resolved further: That in sending notice of the 1938 assessment to chapter treasurers, the treasurer of the Society be instructed to advise each chapter that the assessment is to be computed strictly on the basis of the number of members and associates on the membership roll of the chapter, without regard to whether said members have or have not paid current chapter dues, and to explain that this method of fixing the amount of the assessment on each chapter has been adopted by the conventions of the Society as the most equitable to all chapters.

5. Committee Reports.

a. Grants-in-aid.
b. Lectures and publications.
c. Certificates in commendation of research.

Reports of these three committees are incorporated in the Report of the President.

d. Committee on Policy.

This committee presented a full report embodying important recommendations regarding the future policies of the Society. It was

Voted: To make the main items of the report a special order of business at the April (1938) meeting of the committee.

Definite action on specific recommendations was taken as follows:

1. *Incorporation of the Society.*

It was

Voted: To ask the 38th convention to authorize the Executive Committee to incorporate the Society under the laws of the District of Columbia.

2. *Enrollment in more than one chapter.*

It was

Voted: That those Sigma Xi members and associates who hold dual membership in two chapters of the Society shall pay only one national dues.

6. Eligibility to Membership and Associateship in the Society.

The committee took up once more and discussed at length the action of the 1929 convention which limited the fields of science recognized by Sigma Xi to mathematics, physics, chemistry, astronomy, sciences of the earth, biology in its various branches including psychology, anthropology, medicine in its various branches and engineering in its various branches, and others closely allied thereto.

The secretary presented requests from several chapters for a ruling on eligibility of individuals for work done in the field of education, farm management and agricultural economics. The requests were given full consideration and it was

Voted: That it is the sense of the Executive Committee that the terms "science" and "scientific research" as used in the constitution and by-laws of the Society refer to the natural sciences and not to the social sciences, and that the specific fields included are those listed in the act of the 1929 convention, and stated in appendix 13 of the constitution. Candidates from the fields of the social sciences and the humanities may be elected to membership and associateship in the Society only on the basis of their qualifications as exhibited in the specific fields of the natural sciences as listed by the 1929 convention.

The secretary was directed to acquaint all chapters with this action of the committee in a special communication.

7. Amendment to the Constitution.

At the April (1937) meeting of the committee it was voted to present to the 38th annual convention the following proposed amendment to the constitution:

Article II, Section 4. A petition that a charter of an established chapter be revoked shall be referred to the president of the Society, who shall refer it to the Executive Committee for consideration. If the Executive Committee present the petition to revoke a charter to the convention with recommendation to favorable action, a charter may be revoked by a three-fourths vote of the convention.

The committee took up the matter again with particular reference to the form of expression. The following revised form was proposed:

"The question of the revoking of a charter of an established chapter of Sigma Xi may arise from within the Executive Committee, or from within the body of the Society at large. In any case such question shall receive careful examination by the Executive Committee; and if, after examination and consideration, with due notice in advance to the chapters (as for the granting of charters) the Executive Committee shall recommend the revoking of a charter, such charter may be revoked by a three-fourths vote of the convention."

It was

Voted: To ask the 38th annual convention to postpone consideration of the proposed amendment to the constitution to some future convention.

8. Tax Exemption for Contributions to Sigma Xi Permanent Funds.

The secretary presented the following ruling from the Federal Treasury Department regarding allowing contributors to the permanent funds of the Society to deduct such contributions from income tax returns.

(The letter appears in this issue of the Quarterly, page 64.)

9. Sigma Xi in Canadian Institutions.

Professor Ward recounted to the committee some conversations he had had with the administrative officers and members of the faculty at several Canadian universities. The committee expressed interest, and it was

Voted: That the question of further extension of Sigma Xi in Canadian institutions should be taken up at some future meeting.

10. Sigma Xi Life Membership.

The secretary presented several requests from individuals that a class "life members" be created in the Society. It was

Voted: That the question of creating a class "life members" be considered at some future meeting.

11. Engrossing Diplomas of Members and Associates.

The secretary was authorized to announce to chapters that the engrossing of member and associate diplomas could be done through his office at the cost of 30 cents for each diploma.

12. Unauthorized Sale of the Society's Insignia.

The secretary reported the sale of the Society's emblem by an unauthorized jeweler to an individual without identification either from the national secretary or the chapter secretary.

Mr. Sweet, of the Alumni Committee, offered to take the proper legal steps to protect the Society's emblems under copyright or trade-mark laws. It was

Voted: That the secretary is authorized to proceed in the matter of the protection of the Society's emblems against indiscriminate sales in consultation with Mr. Sweet.

13. Date of the Spring Meeting of the Committee.

It was

Voted: That the spring meeting of the committee should be tentatively set for Washington on April 24.

Adjournment was taken at 4.00 p.m.

Edward Ellery, *Secretary.*

THE THIRTY-EIGHTH CONVENTION

The 38th convention of the Society of the Sigma Xi was held in the Claypool Hotel, Indianapolis, Indiana, December 28, 1937.

1. CALL TO ORDER.

The business session was called to order at 4.00 P.M. by the President, Dr. W. F. Durand of Stanford University.

2. COMMITTEE ON CREDENTIALS.

President Durand announced a committee on credentials as follows:

H. V. Neher, California Institute of Technology
Brian O'Brian, University of Rochester
H. D. Larson, University of New Mexico.

3. REPORT OF THE COMMITTEE ON CREDENTIALS.

The committee received the credentials of the delegates and reported that 56 chapters (with 88 delegates) and 10 clubs (with 14 delegates) were represented as follows:

a. Chapters represented by delegates present (the list of chapters is arranged alphabetically, not chronologically):

Arizona
Brown
Buffalo
California
California Institute of Technology
Carleton
Carnegie Institute of Technology
Chicago
Cincinnati
College of Medicine, University of Illinois
Colorado
Columbia
Cornell
District of Columbia
Harvard
Illinois
Indiana
Iowa
Iowa State
Kansas
Kansas State
Kentucky
Lehigh
Massachusetts Institute of Technology
Mayo
Michigan
Minnesota
Missouri
Nebraska
New York
North Dakota
Ohio State
Oregon
Oregon State
Pennsylvania
Pennsylvania State
Princeton
Purdue
Rensselaer
Rochester
Rutgers
Smith
Stanford
State College of Washington
Swarthmore
Syracuse
Texas
Union
Tulane
University of Washington
Virginia
Washington University
Wesleyan
Wisconsin
Wyoming
Yale

b. Chapters which had reported appointment of delegates, but were not represented:

Case
Maryland
Oklahoma

c. Chapters which had not reported appointment of delegates and were not represented:

California at Los Angeles
Duke
George Washington
Idaho
Johns Hopkins
McGill
Michigan State
North Carolina
Northwestern
Pittsburgh
Utah
Western Reserve
Worcester

d. Clubs represented:

Alabama
Arkansas
Florida
Georgia
Maine
Massachusetts State
New Mexico
Oklahoma A. and M.
St. Louis
West Virginia

e. Officers present:

President Durand, Secretary Ellery, Treasurer Pegram, Professor Stadler, Professor Gortner, Professor Lund, Professor Parker, Mr. Sweet.

The Secretary appends to the report of the Committee on Credentials the following record of attendance at the last five conventions:

	Chapters present and voting	*Total number chapters*	*Clubs present*	*Total number of Clubs*
1932	32	60	9	32
1933	34	62	6	31
1934	46	64	6	32
1935	52	66	12	36
1936	46	68	7	34
1937	56	72	10	34

4. MINUTES OF 37TH CONVENTION.

The account of the proceedings of the 37th convention of the Society, held in Atlantic City, December 29, 1936, as published in the March QUARTERLY for 1937, was approved as printed.

5. REPORT OF THE PRESIDENT. (Page 47, this issue of the QUARTERLY.)

6. REPORT OF THE SECRETARY. (Page 55, this issue of the QUARTERLY.)

7. REPORT OF THE TREASURER. (Page 60, this issue of the QUARTERLY.)

8. ASSESSMENT FOR 1938.

In accordance with the usual procedure and policy of the convention, and upon the recommendation of the Executive Committee, the following resolutions were adopted:

Resolved: That the annual assessment on each chapter for 1938 shall be payable on January 1, 1938, and that the amount of the assessment on each chapter shall be 75 cents multiplied by the number of members and associates of the chapter on January 1, 1938.

Resolved further: That in sending notice of the 1938 assessment to chapter treasurers, the treasurer of the Society be instructed to advise each chapter that the assessment is to be computed strictly on the basis of the number of members and associates on the membership roll of the chapter, without regard to whether said members have or have not paid

current chapter dues, and to explain that this method of fixing the amount of the assessment on each chapter has been adopted by the conventions of the Society as the most equitable to all chapters.

9. GRANTS-IN-AID. (See President's Report.)

10. CERTIFICATES IN COMMENDATION OF RESEARCH. (See President's Report.)

11. LECTURES FOR 1938. (See President's Report.)

12. PROPOSED AMENDMENT TO THE CONSTITUTION.

Article II, Section 4. A petition that a charter of an established chapter be revoked shall be referred to the president of the Society, who shall refer it to the Executive Committee for consideration. If the Executive Committee present the petition to revoke a charter to the convention with recommendation to favorable action, a charter may be revoked by a three-fourths vote of the convention.

At the meeting of the committee held just prior to the 38th convention a revised wording of the amendment was adopted as follows:

The question of the revoking of a charter of an established chapter of Sigma Xi may arise from within the Executive Committee, or from within the body of the Society at large. In any case such question shall receive careful examination by the Executive Committee; and if, after examination and consideration, with due notice in advance to the chapters (as for the granting of charters) the Executive Committee shall recommend the revoking of a charter, such charter may be revoked by a three-fourths vote of the convention.

In view of this change in form of the proposed amendment to the constitution, the Executive Committee asked the 38th convention to postpone consideration of the amendment to some future convention.

13. PETITIONS FOR CHARTERS FOR CHAPTERS.

The Executive Committee presented, with recommendation for favorable action, petitions for charters for chapters from the following institutions:

a. Rice Institute.

It was

Voted: That the petition be granted.

b. Wellesley College.

It was

Voted: That the petition be granted.

c. Massachusetts State College.

It was

Voted: That the petition be granted.

d. University of Florida.

It was

Voted: That the petition be granted.

14. Election of Officers:

The committee on nominations was as follows:

Walter L. Upson, Washington University.
Ralph W. Chaney, California at Berkeley.
Karl Compton, Massachusetts Institute of Technology.

The following officers were proposed:

For President, George A. Baitsell, Yale.
For Secretary, Edward Ellery, Union.
For Treasurer, George B. Pegram, Columbia.
For Member of Executive Committee, Harlow Shapley, Harvard.
For Member of Alumni Committee, Donald L. Sweet, Chicago.

It was

Voted: To instruct the secretary to cast one ballot for each officer as named.

President Durand declared each officer duly elected after the secretary had announced that the ballot had been cast.

15. The 16th Annual Sigma Xi Lecture.

President Durand announced that the 16th annual Sigma Xi lecture would be given by Dr. Irving Langmuir of the Research Laboratory of the General Electric Company, at 8.15 P.M. in the Murat Theatre, on the topic "The Biological Applications of Surface Chemistry."

The president further announced that by agreement with Dr. Langmuir the lecture would not be available in manuscript form, and hence would not be reproduced in the Quarterly.

16. Adjournment.

The 38th convention adjourned at 6.00 P.M.

Edward Ellery, *Secretary.*

A CORRECTION

In the "Half Century Record and History," pages 419 and 1164, Miss Jennie Ada Walker is listed as a deceased member of the Society of the Sigma Xi. The printed record is exactly in accordance with the record on file in the office of the national secretary, but it appears that that record is incorrect. Miss Walker's present address is 4943 Lake Park Ave., Chicago, Ill.

SIGMA XI LECTURES AT CONVENTIONS OF A. A. A. S.

1922—Dr. Livingston Farrand, President of Cornell University.
"The Nation and Its Health."
1923—Dr. Willis R. Whitney, Research Laboratory, General Electric Company.
"The Vacuum—There's Something in It."
1924—Dr. Frederick F. Russell, Director of International Health Board.
"War on Disease, Particularly Yellow Fever and Malaria."
1925—Dr. F. D. Farrell, President, Kansas State College.
"A Desert Becomes a Garden."
1926—Herbert C. Hoover, Secretary of Commerce.
"The Nation and Science."
1927—Clarence Cook Little, President, University of Michigan.
"Opportunities for Research in Mammalian Genetics."
1928—Professor Arthur Compton, University of Chicago.
"What Is Light?"
1929—Professor George Howard Parker, Harvard University.
"Some Aspects of Human Biology."
1930—Dr. C. E. K. Mees, Eastman Kodak Company.
"The Science of Photography."
1931—Dr. C. F. Hirshfeld, Detroit Edison Company.
"Whose Fault?"
1932—Professor Harlow Shapley, Harvard University.
"Fact and Fancy in Cosmogony."
1933—Professor Henry E. Sigerist, Johns Hopkins University.
"The Foundation of Anatomy in the Renaissance."
1934—Professor Earnest A. Hooton, Harvard University.
"Homo Sapiens, Whence and Whither."
1935—John Bellamy Taylor, General Electric Company.
"The Human Eye and the Electric Eye."
1936—Dr. Henry G. Knight, Chief, Bureau of Chemistry and Soils.
"Selenium."
1937—Dr. Irving Langmuir—General Electric Company Research Laboratory.
"The Biological Applications of Surface Chemistry."

PRESIDENT'S REPORT FOR 1937

The year 1937 has been a notable one for our Society. A few of the important happenings are worthy of emphasis. Your Executive Committee asks for the suggestions of the convention on the varied phases of the work of the Society, and for definite action on certain items of the Society's business.

1. The Growth of Sigma Xi.

a. During the year, chapters were installed at George Washington University, the University of Utah, Carnegie Institute of Technology, and Oregon State College. The number of chapters is now seventy-two, and the total enrollment of members and associates active in thees chapters is approximately 15,000. These chapters elect to membership and associateship from 1,000 to 1,200 annually.

b. There are thirty-four Sigma Xi clubs. A Sigma Xi club is a voluntary organization of those members and associates who are connected with an educational institution where there is no chapter, or who have residence in the same city or locality. Clubs do not elect members and associates, but exert an important influence in the promotion of research in their institution or locality. The organization and existence of Sigma Xi clubs now have the official recognition of the Society by the adoption by the 1936 convention of the constitutional amendment definitely authorizing the formation of Sigma Xi clubs and extending to them the privilege of representation at the annual convention. In carrying out the provision of the constitution the Executive Committee has ruled that the following general principles should form the basis of consideration of requests to organize Sigma Xi clubs:

1. that the membership of the club should be not less than twelve members or associates of Sigma Xi;
8. that clubs should hold at least two meetings each academic year with an attendance of not less than ten of the club membership;
3. that clubs should make annual reports of their activities to the national secretary.

On this basis the Executive Committee has during the current year authorized the formation of Sigma Xi clubs at Lewis Institute, the University of Mississippi, the University of Vermont, and Utah State Agricultural College.

2. Eligibility to Membership and Associateship in Sigma Xi.

The 30th convention of Sigma Xi, held in Des Moines on December 28, 1929, took definite action to limit the fields of science officially recognized by the Society to the following: mathematics, physics, chemistry, astronomy, sciences of the earth, biology in its various branches, including psychology, anthropology, medicine in its various branches, and engineering in its various branches. That convention also voted to leave to the Executive Committee

the interpretation of the expression "science, pure and applied" as used in Section 2 of Article I of the national constitution.

All chapters were duly notified of this action of the convention, and were asked, if in doubt about the eligibility of investigators in other fields, to ascertain and be guided by the opinion of the Executive Committee, before election takes place.

From time to time since 1929 definite reports have reached the Executive Committee that some chapters were not limiting their elections in accordance with this action of the convention—that elections have been made from the fields of public speaking, education, farm management, agricultural economics. The practice is not only contrary to the definite action of the convention, but it occasions considerable embarrassment to the individual who may leave the institution where he was elected to take a position in another institution, the chapter in which does not accept his field of work as among those officially recognized by Sigma Xi.

In October, 1936, pursuant to definite instructions from the Executive Committee, the attention of all chapters was again directed to the action of the 1929 convention. The Society may rest assured that its officers are making constant effort to bring the practice of all chapters into conformity with the ruling of the national organization.

3. THE SIGMA XI LECTURES.

a. For 1937.

During the year a series of Sigma Xi lectures by well-known and successful investigators was inaugurated and made available to all chapters and clubs. The choice of subjects and of lecturers was made by a special committee, consisting of Professor L. J. Stadler, chairman, Dr. L. B. Wilson and Professor Kirtley F. Mather. The itineraries were arranged by the national secretary, and the travelling expenses of the lecturers were paid by the national Society. An honorarium of $50 for each lecture and the local expenses were paid by the chapter or club engaging the lecturer. The general topic for the 1937 series was "Frontiers of Science." Five lecturers gave a total of twenty-seven lectures, as follows:

Professor Ernest O. Lawrence, "Atoms, New and Old."
Virginia Polytechnic Institute, Blacksburg, Va.
University of Virginia, Charlottesville, Va.
West Virginia University, Morgantown, W. Va.
University of Cincinnati, Cincinnati, Ohio.
Western Reserve University, Cleveland, Ohio.
St. Louis University, St. Louis, Mo.
Mayo Foundation, Rochester, Minn.
University of Idaho, Moscow, Idaho.
Oregon State College, Corvallis, Oregon.

Professor Harold C. Urey, "Applications of Physical and Chemical Methods to the Problem of the Separation of the Isotopes."
University of Oklahoma, Norman, Okla.

Kansas State College, Manhattan, Kan.
Indiana University, Bloomington, Ind.
University of Wisconsin, Madison, Wis.
Swarthmore College, Swarthmore, Pa.

Professor L. O. Kunkel, "New Views in Virus Disease Research."
Stanford University, California.
University of Colorado, Boulder, Colo.
University of Missouri, Columbia, Mo.

Professor T. S. Painter, "Recent Developments in Our Knowledge of Chromosome Structure and Their Bearing on Genetics."
Swarthmore College, Swarthmore, Pa.
Brown University, Providence, R. I.
Michigan State College, East Lansing, Mich.
University of Missouri, Columbia, Mo.
University of Arkansas, Fayetteville, Ark.
Louisiana State College, Baton Rouge, La.

Professor Edgar Allen, "Internal Secretions in Reproduction."
Tulane University, New Orleans, La.
University of Alabama, University, Ala.
Virginia Polytechnic Institute, Blacksburg, Va.
University of Maine, Orono, Me.

Chapters and clubs and lecturers are unanimous in their enthusiastic appreciation of the value of this latest movement of our great Society in the promotion of research. Several publishing houses have shown definite interest in the publication of the entire series in book form.

b. For 1938.

The committee on lectures for the 1938 series consists of Professor George A. Baitsell, chairman, Professor Kirtley F. Mather, Professor L. J. Stadler, and Professor Harold C. Urey. The topic for the series is "Recent Advancements in Bio-chemistry." Lecturers, specific topics, and available dates are as follows:

Dr. W. M. Stanley, Rockefeller Institute, "Studies on Virus Proteins," April 16 to 30.

Dr. R. R. Williams, Bell Telephone Laboratories, "Vitamin B_1 and Cell Metabolism," April 10 to 24.

Dr. K. E. Mason, Vanderbilt University, "Vitamins and Hormones," April 17 to May 1.

Dr. F. G. Benedict, Nutrition Laboratory, Boston, "Animal Metabolism—from Mouse to Elephant," March 1 to 15.

Dr. E. N. Harvey, Princeton University, "Electrical Potentials of the Human Brain," January 26 to February 9.

Announcement of the 1938 series was sent to all chapters and clubs December 9.

4. The Williams Memorial.

It is well known to all our members and associates that the Society of the Sigma Xi was started on its notable career by a group of engineers, but the group always had in mind the idea that the organization should be a companionship of workers in pure, as well as in applied science. Professor Henry Shaler Williams, geologist and professor at Cornell University when Sigma Xi was founded, was elected into the Society at the fourth meeting of the founding group, undated, but doubtless early in 1887. Professor Williams' counsel and ideas and ideals exerted such profound influence in shaping and directing the policies of the Society of the Sigma Xi in its formative years, that the national officers of the Society, the Cornell Chapter, and the living founders considered eminently appropriate a memorial celebration of the fiftieth anniversary of his election into membership.

The celebration took place at Ithaca, April 23, 1937. Three of the founders were present—Colonel Frank Van Vleck, Professor Charles Benjamin Wing and Mr. John Knickerbacker—and all gave addresses. Professor B. F. Kingsbury, president of the Cornell Chapter, spoke on "Sigma Xi and the Unity of Science," and Professor Armin O. Leuschner, a member of the Executive Committee of the national organization, delivered an address on "Research as a Function of Universities."

The Society at large and the parent chapter are deeply grateful to all who contributed so enthusiastically to the program, and especially to the founder, Mr. John Knickerbacker, who was in constant contact with the committee of arrangements with helpful ideas, and without whom some features of the successful event would not have been possible.

5. Petitions for Charters for Chapters.

The Executive Committee presents to this convention petitions for charters for chapters from four institutions—Wellesley College, Rice Institute, University of Florida and Massachusetts State College. Copies of these petitions were distributed to the chapters in October, with the request that the national secretary be informed when they had been received. To date (December 15) sixty-three chapters have acknowledged receipt of the petitions.

It is pertinent in this connection to call your attention to what precedes the presentation to a convention of a formal petition for a charter for a chapter. The conventions of 1916 and 1917 ruled that the following conditions should hold in any institution if the Executive Committee is to make a favorable report upon an application for a charter:

1. The authorities of the college or university, *i.e.*, the trustees and the president, should be favorably disposed toward research.
2. There should be apparatus and facilities available for research.
3. The members of the faculty who sign the petition should be men who have had adequate training for research.
4. There should have been a continuous output of research from the institution for a number of years preceding the application for a charter.

5. There should be appropriations for research, or at least a certain amount of the appropriations made to the scientific department should be available for apparatus for research.

In accordance with those instructions from the convention, information in detail is sought about an institution in which a group is contemplating submitting a petition. Such information includes number of students in the current year, five and ten years previous; number of professors and instructors; number of undergraduate and graduate degrees granted; financial resources, together with average salaries of the full professors; list of colleges and departments; research activity as indicated by number of investigators, published papers, facilities for research, expenditures for research; scientific training and record of the individual signers of the petition.

If after study of that information the conditions at the institution seem favorable toward the promotion of research, an official visitor to the institution is appointed, who makes a personal survey of the resources and equipment, confers with administrative officers and department heads, studies the prospects of development of the institution in the immediate future, forms a judgment as to whether the objects of Sigma Xi will be met if a chapter is established, whether the institution will be benefited thereby, whether the petitioners and those likely to be associated with them later can be expected to sustain the chapter at a satisfactory level.

The official visitor makes formal report of his findings to the Executive Committee, and, basing action on other complete information and expert judgment about an institution, the Executive Committee may permit a formal petition for a charter for a chapter to come before a convention with a recommendation to favorable consideration. Thus several years may elapse between the first preliminary inquiries from an institution and the final presentation of a petition, and it may also happen that inquiries never reach the petition stage.

There are six institutions now under consideration by the Executive Committee. These studies may or may not result in a formal petition for a charter for a chapter to some future convention.

The Executive Committee will welcome comments and further instructions from the convention on this important task of investigation of institutions. The four petitions presented to this convention are the result of this carefully conducted study. The reports of the official visitors (Wellesley, Professor Baitsell of Yale and Ellery of Union; Rice Institute, Dr. Durand of Stanford University; University of Florida, Dr. H. G. Knight of the U. S. Bureau of Chemistry and Soils; Massachusetts State College, Professor G. H. Parker of Harvard) are on file, together with the detailed information about the institutions.

The convention will be interested to know that at Wellesley 13 of the 17 petitioners are listed in American Men of Science; at Rice, 15 of 22; at Florida, 42 of 52; at Massachusetts State, 25 of 37.

Chapter delegations vote as a unit on petitions, and a three-fourths vote of the convention is necessary for granting a charter for a chapter. All

charters granted since 1922 (38 out of the total of 72) carry the provision that undergraduates of the institutions are eligible to election as associates only.

6. Grants-in-aid of Research.

Continuing the policy of the Society in operation since 1921, the Society through its committee of award of grants-in-aid (Dr. W. R. Whitney, chairman, Professor Harlow Shapley, Professor Gary N. Calkins) has distributed during the year the sum of $2,000 to nine candidates from a group of twenty-two applicants. Appended is the list of the individuals, their position and project, and the sum granted each:

Professor Alan Arthur Boyden, Rutgers University, $150. Project: "Serological Study of the Relationship of Crustacea."

Professor Leopold Raymond Cerecedo, Fordham University, $250. Project: "Development of a 2-day test for the bio-assay of antineuritic concentrates in mice."

Professor Forrest F. Cleveland and Professor M. J. Murray, Lynchburg College, $300. Project: "Raman effect and molecular structure."

Professor Maurice Ewing, Lehigh University, $200 (on condition that he gets $161.25 from some other source). Project: "Geophysical investigations of oceanic basins." (Since the meeting of the committee Lehigh University has awarded Professor Ewing the amount of $161.25.)

Professor George William Hunter, III, Wesleyan University, $250. Project: "Studies of the reaction of the host to the penetration of larval parasites."

Professor Louallen F. Miller, University of Minnesota, $250. Project: "Solar radiation by spherical absorber."

Mr. Edgar J. Murphy, College of the City of New York, $150. Project: "Design, construction and calibration of suitable apparatus for measurement of X-rays and Gamma rays. A study of the stray radiation in the vicinity of the X-ray tubes and radium packs located in the various city hospitals. Design and construction of Geiger Muller tubes for measuring high intensity radiation."

Professor Jens Rud Nielsen, University of Oklahoma, $200. Project: "Raman spectra and structure of simple polyatomic molecules."

Mr. Aaron John Sharp, University of Tennessee, $250. Project: "Study of types and distribution of certain bryophytes and spermatophytes."

7. Certificates in Commendation of Research.

The 32nd convention in New Orleans, December 29, 1931, authorized the Executive Committee to award certificates in commendation of research to qualified students in institutions where there is no chapter, upon the basis of a thesis and scholastic record and the recommendation of some member of the faculty competent to express judgment. The credentials are reviewed by a special committee of award appointed annually by your president. The fields of work are at present limited to biology, chemistry and physics, and

the number of candidates is limited to one student in each field in the institutions which present them. The number of institutions naming candidates has varied from five to seven, and the awards from ten to eighteen.

This year the candidates number five, from three institutions. The committee of award is headed by Professor E. O. Lawrence of the University of California at Berkeley. The following awards have been made:

Amedeo Bondi, Jr., Massachusetts State College, "Effect of Bacteriophage on Reactions of Certain Members of the Coli-Aerogenes Group of Bacteria."

Alfred Eastman Newton, Massachusetts State College, "Precipitation of Ammonium Molybdates by Nitric Acid."

Ronald H. Bingham, University of Vermont, "Relative Intensity Measurements on the Hyperfine Structure Patterns of Some Lines in the Arc Spectrum of Manganese."

William Carson Brown, West Virginia University, "Studies of Oxidized Flavor in Milk."

8. A National Policy for the Society of the Sigma Xi.

In the first quarter century, and a little more, of the life of our great Society, its activities were largely confined to chapter meetings, the annual election of such undergraduate and graduate students who showed in their student career special promise of future achievement in research, and the publication in a Quarterly journal of desirable scientific articles. Since 1922 the special functions of Sigma Xi in fulfillment of its object, the promotion of research in pure and applied science, have broadened and include all of the following:

a. Organization of Sigma Xi clubs as well as chapters.

b. Meetings of chapters and clubs for the discussion of scientific subjects.

c. Fostering and maintaining fraternal relations among investigators by authorizing chapters and clubs outside educational institutions.

d. Granting chapter membership to individuals who have, by actual work of investigation, exhibited aptitude for scientific research.

e. Granting chapter associateship to undergraduates who have shown marked excellence in one or more departments of pure or applied science, who may not have done actual research work.

f. The quarterly publication of a scientific journal, with a present subscription list of nearly 17,000.

g. Appointment of an official jeweler, who alone is authorized to issue the Society's emblems on orders from the national secretary, countersigned by the chapter secretary.

h. The establishment of a permanent endowment fund, now amounting to approximately $40,000.

i. The award of grants-in-aid of research.

j. The award of prizes for research accomplished and in progress.

k. The award of certificates in commendation of research to properly qualified students of educational institutions where there is no chapter.

l. The presentation of an annual lecture at the meetings of the Association for the Advancement of Science.

m. Maintaining an annual series of lectures on the most recent work in special fields of scientific research.

Your Executive Committee is of the opinion that the time has now arrived when a definite Sigma Xi policy must be shaped, embodying all those activities and formulating a plan for possible further expansion in the immediate future. Hence a committee on policy has been appointed and is at work. It consists of Professor Gortner, Minnesota, chairman, Professor Leuschner, California, and Professor Miller, Case, representing the Executive Committee; Professor Parker, Harvard, and Professor Baitsell, Yale, representing past officers of the Society; Mr. Davies, Rensselaer, and Mr. Norton, Cornell, representing the alumni. It is expected that the committee will be prepared to present a report and suggestions at an early convention of the Society.

W. F. DURAND.

The Setting of a Gel—Physiological Implications

(*Concluded from page 34*)

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REPORT OF SECRETARY FOR 1937

Your secretary reports on matters which, while routine, are of daily importance in the conduct of the Society's ever-expanding business. The president's report lists the present-day activities of the Society and that will give you some idea of how the demands on the secretary's office have increased in the last decade. The purpose of the report of the secretary is to acquaint the convention and, by that means, the Society at large with a few of the larger details of the work of the office.

1. The Sigma Xi Semi-centennial Record and History.

The volume made its public appearance in the spring of this fiscal year. It numbers over 1,200 pages, contains the fifty-year history of the Society, the history of each of the sixty-eight chapters whose charters had been granted up to and including the year 1936, and the history of the twenty-six Sigma Xi clubs in existence in 1936. It gives the names of our more than 40,000 members and associates printed twice: (a) in the chapter enrollment, which includes not only the name of the individual, but also the date of his initiation, his field of work, and his last known mailing address; (b) in an alphabetical index. It gives also a hobbies index, containing 5,000 names (all who stated a hobby in response to the request for biographical information sent out from the secretary's office in 1935 and 1936). The hobbies are arranged alphabetically, and individuals are similarly listed under each hobby.

Other features of the volume are photographs of the living founders who were present at the semi-centennial celebration in Ithaca, June 20, 1936, and of the stately memorial tablet in bronze erected by the Society on a pedestal given by the trustees of Cornell University; and reproduction of the minutes of the first six meetings of the parent chapter where national policies were taking shape. Thus are preserved in permanent form, and made available for the entire organization, the small beginnings of the Society of the Sigma Xi, which has expanded into the present important and influential organization of the scientific world, and which is still expanding.

The edition numbered 4,000 copies, of which 3,164 have already been shipped to as many subscribers. We are sending out copies to new subscribers at the rate of six to ten a week, but we want to be able to keep in storage at least 300 copies to meet sporadic subscriptions during the next quarter century.

Of course in a completed work of this kind, or in any important work, the worker is interested in, and looks for, inaccuracies. In typing and printing 85,000 names, one would expect clerical and typographical errors. To date, we have learned of one such, but doubtless there are more. One subscriber expressed disappointment that a professional title was omitted from the printed record, but reference to the files in the secretary's office revealed that the name was printed in the History exactly as it appears in our records.

A glaring error is apparent in the printed list of the 1929 initiates of the Cornell Chapter. The names of only two-thirds of the individuals

elected by the Cornell Chapter in that year appear in the History. Agai reference to the records on file in the secretary's office shows the, to u startling and inexplicable fact that we do not have any record at all, in th chapter files or the alphabetical files of the secretary's office, of the person whose names are unfortunately omitted from the printed History. With th cooperation of the secretary of the Cornell Chapter we are now completing the records for that year, but of course the names of the individuals wi not appear in a printed record until the publication of the Three Quarte Century Record and History.

2. THE QUARTERLY.

In view of the many scientific journals which publish the results o research in special fields, and of interest and value to workers in these fields, and in view of the further fact that Sigma Xi members and associate constitute a companionship of workers in all fields, the stated and definit editorial policy of the Society's official journal is to find and publish papers calculated to be of interest to all our constituency, rather than to any on group. The 1937 numbers have expressed this policy fairly well. Eleve articles have appeared, as follows:

"Public Health and Selenium in Soils," by Dr. H. G. Knight, Chief o the U. S. Bureau of Chemistry and Soils.

"City Scientific Planning," by Professor G. H. Shepard, Purdue Un versity.

"Education and the Present World Crisis," by the late Dr. William Alanson White, at the time the paper was given, Superintendent o St. Elizabeth Hospital, Washington, D. C.

"The Unity of Science," by Professor B. F. Kingsbury, Cornell Univer sity.

"Universities and Research," by Professor A. O. Leuschner, University of California at Berkeley.

"Power and Civilization," by Dr. W. F. Durand, Stanford University.

"Aerological Research, a Study of the Upper Air," by Dr. Willis R. Gregg, Chief of the U. S. Weather Bureau.

"Genetics and Evolution," by Dean Fernandez Payne, Indiana University

"Clinical Investigations," by Dr. William S. McCann, University o Rochester.

"Psychophysiologic Relationships," by Dr. Ernst Gellhorn, College o Medicine, University of Illinois.

"The Urge to Know," by Professor Frank Studer, Union College.

In prospect for coming issues are:

"The Wisdom of the Mind," by Professor John M. Fletcher, Tulane University.

"The Inheritance of Emotionality," by Dr. Calvin S. Hall, Western Reserve University.

"Plant Transpiration," by Dr. Burton E. Livingston, Johns Hopkins University.

The June issue of the year contains the full account of the Williams Memorial at Ithaca, with photographs of the founders who were present. Two of these, Professor Wing and Mr. Knickerbacker, had not been able to attend the semi-centennial a year ago. Thus, with the photographs reproduced in the Half Century Record and History, we have in permanent form photographs of all five of the founders living in the fiftieth year of the Society's existence.

Your secretary is of the definite opinion that the time has arrived for transferring the editorship of the SIGMA XI QUARTERLY to an editorial board. The present editorial policy is probably correct, but the importance and influence of the journal and its large subscription list (over 16,000) requires that editorial responsibility be placed on more competent shoulders than his.

Your secretary desires to emphasize the implications of that large subscription list (16,500 for the December issue).

a. The address list is maintained in the secretary's office, of course. That is the only place where the frequent necessary changes can be made. That means that four times a year 16,000 wrappers are addressed—an annual total of 64,000 wrappers. Fortunately the Society now owns an electrically driven addressograph, and the time required for addressing wrappers has been reduced from ten days for two clerks to approximately four days for one clerk.

b. It is difficult, almost impossible with the clerical force at the Society's command, to keep the address list correct up to the date of any single issue. An avalanche of changes descends on the secretary's office with the September issue, and a somewhat smaller number, but still large, with the June issue. This is a normal condition with our particular clientele. Each new academic year sees considerable alteration in chapter enrollments, due to faculty migrations, especially in the younger groups. The secretary's office cannot get the corrected chapter enrollment until well into October—that is, not until after the September issue, which goes to the addresses which were correct in June, but are not correct in September.

Each spring brings us the names and addresses of the new members and associates, and this constitutes another cause of address inaccuracies in the fall. It is the policy of the Society to send the QUARTERLY to each newly initiated member and associate for one year following the date of initiation. Since most elections take place in the spring, the addresses of the initiates on the cards sent to the national secretary are those of that particular time—in many cases the institution where the individual has been initiated. Many of the students, having completed their college or university work, leave the institution in June, and of course chapter secretaries do not know their changed address. But the QUARTERLY goes to the individual at the address on the filing card, which is frequently incorrect. At the expiration of a year, all those names must be removed from the mailing list, and files changed accordingly.

This all involves a large number of postal returns after the September issue—amounting this autumn to several hundred copies, with the expense of returned postage and of clerical time in changing the records.

What do you think is the way out of this difficulty? Shall we publish in other months than March, June, September and December, so as to bring one issue in November? Shall we abandon the policy of sending the journal for one year to the new initiates? The Executive Committee and the harassed secretary will welcome comments and suggestions.

3. The Sigma Xi Insignia.

Since 1922 the Society has had an official jeweller, and all orders for emblems are issued through the office of the national secretary upon authorization of chapter secretaries. This procedure is necessary to secure uniformity of style, and to protect the emblems against counterfeiting and against sale to other than *bona fide* members and associates. From 800 to 1,200 orders are filled each year. Very few instances of manufacture of Sigma Xi emblems by other than the official jeweller and of sale to unidentified individuals come to the knowledge of the national secretary. The latest infringement of the Society's property rights in its own insignia will interest you, as well as confirm the wisdom of our regulations regarding the manufacture and sale of our emblems. It came to light last month. An individual was elected to associateship by a chapter in the Middle West in 1933. A friend, wishing to make him a gift, presented him with a member emblem which he was not entitled to wear, manufactured by an unauthorized jeweller and sold to the purchaser without requisition either from the chapter secretary or the national secretary. One can realize the embarrassment of the recipient at possessing a Sigma Xi emblem to which he has no right, sympathize with him, and admire his honesty in bringing the episode to the knowledge of the national secretary. We have offered to issue to the troubled individual an official associate emblem, and give full credit for the member emblem, although it is not a product of our own jeweller. The offer has not been accepted to date. The secretary of the chapter in which this incident occurred is of the opinion that the offending jeweller is well known, with a local branch, and that it sells Sigma Xi emblems to anyone who asks for them, without identification.

4. Official Stationery for Chapters.

Upon authority from the Executive Committee, the national secretary is now prepared to distribute sheets of stationery in blue, bearing the official seal of the Society embossed in white (the Society's colors) and the name and address of the chapter, and matching envelopes with the appropriate business card, at $1.00 per 100 sheets, and $1.00 per 100 envelopes. Samples are here for your inspection.

5. Official Diplomas.

For many years diplomas for members and for associates have been available. The wording is fixed by the constitution, but the form has changed several times. The diplomas are printed on a kind of parchment

and carry the seal of the Society on a gold leaf, held in place by a blue ribbon. Beginning with the 1938 elections, the secretary is prepared to arrange for embossing the certificates with the name of the individual, the chapter name, and the date in a style of type similar to that used in the diploma itself. The cost of the diploma is 10 cents. Engrossing can be done at a cost of 30 cents. Samples are here for the inspection of the delegates.

6. Income Tax Exemption on Contributions.

Acting upon the request of some contributors to the Sigma Xi permanent funds, a ruling has been secured from the Federal Internal Revenue authority in charge of the collection of income taxes, to the effect that all contributions to Sigma Xi are tax exempt, and may be deducted on the annual income tax returns.

7. Cooperation of Chapter and Club Secretaries.

A glance over the 1937 list of chapters and clubs will give some idea of the amount of chapter and club correspondence that passes through the office of the national secretary. In addition to annual reports of chapter and club secretaries, chapter secretaries are expected to send index cards for newly elected members and associates for filing in the permanent records of the Society. These are the only source of this necessary biographical information. The cards give the name and mailing address of the individual, date of election, field of work, group from which elected (undergraduate, graduate, faculty). When these cards reach the office of the national secretary, a card is typed for the alphabetical file of members and associates, and a stencil made for the addressograph, which also constitutes a geographical file. Chapter secretaries are also expected to submit each fall (as noted elsewhere) the chapter enrollment for the year. What this means in the office of the national secretary you can readily understand, when it is recalled that in 1921 there were thirty-four chapters and in 1937 there are seventy-two chapters. In 1921 there were no clubs. In 1937 there are thirty-four. The filing of these cards and lists constitutes only one part of the work which the chapter secretary is called upon to do in his chapter. In the main the responsibility is carried promptly and accurately.

To date (December 14) filing cards for new members and associates elected in 1937 have been received from fifty-three of the seventy-two chapters, as follows:

Syracuse	Indiana	Cincinnati
Pennsylvania	Iowa	Maryland
Kentucky	Tulane	Columbia
Kansas State	Brown	Idaho
Pennsylvania State	Princeton	New York University
Wesleyan	Michigan	Rochester
Smith	Washington University	Virginia
Union	Arizona	Pittsburgh
Chicago	Texas	Wisconsin

(*Please turn to page 65*)

REPORT OF THE TREASURER OF THE SIGMA XI SOCIETY FOR 1937

RECEIPTS

Cash on hand, December 31, 1936	$ 5,339.46	
Chapter assessments for 1937	7,858.31	
Chapter assessments for 1936, arrears	262.50	
Chapter assessments for 1938, advance	35.50	
Initiation fees for 1937	2,622.00	
Initiation fees for 1936, arrears	68.00	
Installation fees	200.00	
Interest on investments	1,380.79	
Sale of 3 U. S. Treasury bonds 3% at 101 10/32	3,039.38	
Sale of 2 New York City bonds 4%	200.00	
Sale of insignia in 1936	825.00	
Overpayments	76.12	
Semi-Centennial Fund	4,980.40	
		$26,887.46

DISBURSEMENTS

Secretary's office (total, $5,114.39)		
assistants	$ 2,677.00	
office supplies, stamps, etc.	637.39	
secretary's stipend	1,800.00	
Treasurer's office (total, $215.89)		
assistant	150.00	
office filing cabinet	36.89	
auditing 1936 books	10.00	
postage, etc.	19.00	
Officers' travelling expenses	1,259.30	
Quarterly (5 issues)	2,716.34	
Engrossing charters	192.65	
Semi-Centennial expenses	6,664.46	
Special secretary's office expenses	4,107.18	
Lecturers' expenses	1,098.23	
Grants-in-aid of research for 1935-36-37	2,458.37	
Refunds	76.12	
Miscellaneous	7.85	
		$23,910.78
Cash on hand, December 31, 1937		2,976.68
		$26,887.46

GEORGE B. PEGRAM, *Treasurer.*

December 31, 1937.

ALUMNI FUND

RECEIPTS

Cash on hand, December 31, 1936	$ 000.00	
Borrowed from Society funds	2,458.37	
		$ 2,458.37

DISBURSEMENTS

Research:		
N. W. Cummings (1935-36)	$ 58.37	
J. Valasek (1936-37)	300.00	
C. W. Buggs (1936-37)	100.00	
J. Rud Nielsen (1937-38)	200.00	
George W. Hunter III (1937-38)	250.00	
L. R. Cerecedo (1937-38)	250.00	
Maurice Ewing (1937-38)	200.00	
F. F. Cleveland and M. J. Murray (1937-38)	300.00	
Aaron J. Sharp (1937-38)	250.00	
Alan Boyden (1937-38)	150.00	
E. J. Murphy (1937-38)	150.00	
L. F. Miller (1937-38)	250.00	
		$ 2,458.37
Cash on hand, December 31, 1937	000.00	
		$ 2,458.37

ALUMNI FUND ACCOUNT WITH SOCIETY

Borrowed for research grants, 1935-36-37	$ 4,355.38
2 Southern Pacific 4½% 1969 bonds turned over	1,812.75
Balance indebtedness	$ 2,542.63

SEMI-CENTENNIAL FUND

Receipts 1936	$13,549.63	
Receipts 1937	4,980.40	
		$18,530.03
Cost of 3,164 copies of History of Sigma Xi sent to contributors of $3.50 or more		6,664.46
Balance		$11,865.57

GEORGE B. PEGRAM, *Treasurer.*

December 31, 1937.

INVESTMENT ACCOUNT
(Securities carried at cost)

All companies continue to pay interest on their bonds except the St. Louis and San Francisco Railway, which is in receivership.	
$1,000 Amer. Tel. & Tel. Co. 5½% (1943) bond at	$ 991.94
$1,000 St. Louis & San Francisco Railway 4% (1950) bond (certificate of deposit)	796.35
$1,000 Baltimore & Ohio Railway 5% (2000) bond at	955.00
$1,000 Philadelphia Company 5% (1967) bond at	979.50
$1,000 Erie Railroad Company 5% (1967) bond at	947.00
$1,000 Southern Railway Company 6% (1956) bond at	1,152.00
$1,000 Philadelphia Company 5% (1967) bond at	997.00
$1,000 Canadian Pacific 5% (1954) bond at	1,010.00
$1,000 U. S. Treasury 4% (1954) bond at	999.06
$1,000 U. S. Treasury 3% (1955) bond at	942.50
$1,000 U. S. Treasury 3% (1955) bond at	942.50
$1,000 U. S. Treasury 3% (1955) bond at	942.50
$1,000 U. S. Treasury 2⅛% (1939) bond at	1,019.37½
$1,000 U. S. Treasury 2⅛% (1939) bond at	1,019.37½
$1,000 U. S. Treasury 2⅛% (1939) bond at	1,019.37½
$1,000 U. S. Treasury 2⅛% (1939) bond at	1,019.37½
$1,000 U. S. Treasury 2⅛% (1939) bond at	1,019.37½
$1,000 U. S. Treasury 2⅛% (1939) bond at	1,019.37½
$200 New York City 4% (1938) bond at	198.50
$200 New York City 4% (1939) bond at	198.50
$200 New York City 4% (1940) bond at	198.50
$200 New York City 4% (1941) bond at	198.50
$200 New York City 4% (1942) bond at	198.50
$200 New York City 4% (1943) bond at	198.50
$1,000 Southern California Edison Co. 3¾% (1960) bond at	1,065.00
$1,000 Southern California Edison Co. 3¾% (1960) bond at	1,065.00
$1,000 Consumers Power Co. 3½% (1965) bond at	1,057.50
$1,000 Consumers Power Co. 3½% (1965) bond at	1,057.50
$1,000 Edison Elec. & Illum. Co. 3½% (1965) bond at	1,071.25
$1,000 Edison Elec. & Illum. Co. 3½% (1965) bond at	1,071.25
$1,000 General Motors Acceptance Co. 3% (1946) bond at	1,027.50
$1,000 General Motors Acceptance Co. 3% (1946) bond at	1,027.50
$1,000 General Motors Acceptance Co. 3% (1946) bond at	1,027.50
$1,000 Consolidated Edison Co. 3¼% (1946) bond at	1,047.50
$1,000 Consolidated Edison Co. 3¼% (1946) bond at	1,047.50
$1,000 Consolidated Edison Co. 3¼% (1946) bond at	1,047.50
$1,000 U. S. Treasury 3⅛% (1946/49) bond at	1,069.06½
$1,000 U. S. Treasury 3⅛% (1946/49) bond at	1,069.06½
$1,000 U. S. Treasury 3⅛% (1946/49) bond at	1,069.06½
$1,000 Southern Pacific Co. 4½% (1969) bond at	905.75
$1,000 Southern Pacific Co. 4½% (1969) bond at	907.00
	$36,595.04

December 31, 1937.

GEORGE B. PEGRAM, *Treasurer.*

AUDITORS' STATEMENT

We have audited the accounts of the Treasurer of Sigma Xi for the year ending December 31, 1937, and certify that the income shown by the books of the Treasurer has been duly accounted for, that payments have been properly vouched and that the balance sheet and accounts submitted contain a true statement of the financial condition of the Society. We have also examined the securities in the hands of the Treasurer and find the following bonds: $1,000 Amer. Tel. & Tel. Co.; $1,000 St. Louis and San Francisco Railway Co. (certificate of deposit); $1,000 Baltimore & Ohio Railway; $1,000 Philadelphia Co.; $1,000 Erie Railroad; $1,000 Southern Railway; $1,000 Philadelphia Co.; $1,000 Canadian Pacific; $1,000 U. S. Treasury; $1,000 U. S. Treasury; $1,000 U. S. Treasury; $1,000 U. S. Treasury; $1,000 U. S. Treasury; $1,000 U. S. Treasury; $1,00 U. S. Treasury; $1,000 U. S. Treasury; $1,000 U. S. Treasury; $1,000 U. S. Treasury; $200 New York City; $200 New York City; $200 New York City; $200 New York City; $200 New York City; $200 New York City; $1,000 Southern California Edison; $1,000 Southern California Edison; $1,000 Consumers Power; $1,000 Consumers Power; $1,000 Edison Electric and Illuminating; $1,000 Edison Electric and Illuminating; $1,000 General Motors Acceptance; $1,000 General Motors Acceptance; $1,000 General Motors Acceptance; $1,000 Consolidated Edison; $1,000 Consolidated Edison; $1,000 Consolidated Edison; $1,000 U. S. Treasury; $1,000 U. S. Treasury; $1,000 U. S. Treasury; $1,000 Southern Pacific; $1,000 Southern Pacific.

J. T. FINNERAN,
FRANK X. FARR,
Auditors

January 22, 1938.

TREASURY DEPARTMENT

WASHINGTON

OFFICE OF COMMISSIONER OF INTERNAL REVENUE

Society of the Sigma Xi,
c/o Mr. Edward Ellery, Secretary,
Union College,
Schenectady, New York.

Sirs:

Reference is made to the evidence submitted by you for use in determining your status for Federal income tax purposes in order to ascertain whether or not contributions to your organization are allowable deductions in Federal income tax returns of donors.

The evidence indicates that you are not incorporated and were organized in 1886 with the object of encouraging original investigation in science, pure and applied, and the special functions of your society in fulfillment of the above object are stated to be as follows:

(a) The holding of meetings for the discussion of scientific subjects.

(b) The establishment of fraternal relations among investigators in the scientific centers.

(c) The granting of membership to such students as have, during their college course, given special promise of future achievement.

(d) The publication of such scientific matter as may be deemed desirable.

(e) The support of fellowships for research.

Your work is carried on through institutional and alumni chapters chartered by you in approved institutions for the advancement and encouragement in original research and science.

Your society consists of members and associates and your constitution provides that only a professor, instructor, or other member of the staff of the institution who has shown noteworthy achievement as an original investigator in some branch of pure or applied science or a student in the institution who, as judged by his actual work of investigation, has exhibited an aptitude for scientific research, may be eligible to election as a member in a chapter at any institution.

Your secretary states that, in accomplishing your purpose, you honor with memberships young men and women in colleges and universities who show special aptitude for scientific research, publish a scientific journal and make grants in aid of research. You make no effort to influence legislation, have no capital stock and no part of your income inures to the benefit of any private shareholder or individual. The report of your treasurer for the year 1936 indicates receipts principally from chapter assessments, initiation fees, interest on investments, sale of securities, and for the semi-centennial endowment fund with disbursements for the expenses of offices of the secretary and treasurer,

publication of your journal, traveling expenses of officers and your semi-centennial exposition.

Based upon the facts presented, it is held that you are entitled to exemption under the provisions of section 101(6) of the Revenue Act of 1936 and the corresponding provisions of prior revenue acts. You are not, therefore, required to file returns for 1936 and prior years, and future returns will not be required so long as there is no change in your organization, your purposes, or method of operation.

Any changes in your form of organization or method of operation, as shown by the evidence submitted, must be immediately reported to the collector of internal revenue for your district, in order that the effect of such changes upon your present exempt status may be determined.

The exemption granted in this letter does not apply to taxes levied under other titles or provisions of the respective revenue acts except insofar as exemption is granted expressly under those provisions to organizations enumerated in section 101 of the Revenue Act of 1936 and the corresponding provisions of prior revenue acts.

Contributions to your organization by individual donors are deductible by such individuals in arriving at their taxable net income in the manner and to the extent provided by section 23(o) of the Revenue Act of 1936 and the corresponding provisions of prior revenue acts. The deductibility of contributions by corporations is governed by section 23(q) of the Revenue Act of 1936.

A copy of this letter is being transmitted to the collector of internal revenue for your district.

By direction of the Commissioner.

Respectfully,

HENRY SHERWOOD,
Acting Deputy Commissioner.

Report of Secretary for 1937

(*Concluded from page 59*)

Worcester Poly. Inst.	Oregon State	Minnesota
Rensselaer Poly. Inst.	Northwestern	Michigan State
Massachusetts Inst. of Tech.	Case	Cornell
	College of Medicine, University of Illinois	Illinois
Iowa State		Utah
Colorado	Ohio State	Yale
North Carolina	California	Stanford
Nebraska	Mayo	Oklahoma
Purdue	University of Washington	Harvard

The national secretary desires in this annual report to express appreciation of the way in which chapter and club secretaries meet this obligation to the national organization. Their cooperation is splendid, and the Society as a whole is benefited.

EDWARD ELLERY, *National Secretary.*

CHAPTER OFFICERS

List Furnished by the Secretaries of the Chapters

Chapter	President	Vice-President	Secretary	Tre
Cornell	K. M. Wiegand	J. R. Johnson	P. F. Sharp	A. J. He
Rensselaer	H. S. Van Klooster	H. E. Stevens	D. T. Smith	H. D. B
Union	E. S. C. Smith	V. Rojansky	A. H. Fox	R. W.
Kansas	N. P. Sherwood	W. C. McNown	W. H. Schoewe	H. E.
Yale	A. F. Kovarik	L. S. Stone	F. T. McNamara	H. J.
Minnesota	F. K. Butters	J. M. Bryant	H. Macy	W. H.
Nebraska	H. W. Manter	E. N. Andersen	M. A. Basoco	M. G.
Ohio State	F. A. Hitchcock	W. G. France	W. C. Fernelius	W. C.
Pennsylvania	J. L. Appleton	J. R. Kline	E. M. Landis	J. M. F
Brown	H. E. Walter	C. W. Miller	P. H. Mitchell	W. E.
Iowa	H. O. Croft	Beth L. Wellman	W. F. Mengert	A. T.
Stanford	C. P. Stone	S. B. Morris	K. M. Cowdery	K. H.
California	E. O. Lawrence	N. E. A. Hinds	H. Kirby	H. E.
Columbia	H. W. Webb	A. W. Thomas	D. P. Mitchell	D. P. M
Chicago	C. R. Moore	A. J. Dempster	R. G. Sanger	H. C.
Michigan	A. H. Higbie	H. H. Willard	J. S. Gault	C. B. S
Illinois	C. L. Metcalf	W. L. Schulz	E. G. Young	D. T. E
Case	G. L. Tuve	G. E. Barnes	R. L. Burington	T. M. F
Indiana	A. C. Kinsey	C. M. Louttit	R. J. Hartman	R. L.
Missouri	Mary Guthrie	N. R. Ziegler	G. F. Breckenridge	F. McK
Colorado	Edna L. Johnson	I. C. Hall T. H. Howells	Hugo Rodeck	W. K.
Northwestern	H. A. Simmons	A. Weil	M. Dole	A. L. H
Syracuse	C. C. Spencer	W. Greene	V. F. Lindenman	Mildred F
Wisconsin	H. W. Mossman	L. E. Noland	C. A. Richards	W. B. S
Univ. of Wash.	B. L. Grondal	A. V. Eastman	D. H. Loughridge	T. S.
Worcester	R. A. Beth	M. L. Price	W. E. Lawton	H. B. F
Purdue	M. G. Mellon	C. J. Klemme	E. J. Kohl	G. A. H
Washington Univ.	E. Anderson	B. E. Lischer	R. E. Woodson	A. S. G
Dist. of Columbia	V. du Vigneaud	N. H. Heck	O. S. Adams	Wm. L
Texas	H. R. Henze	L. J. B. LaCoste	H. F. Rosene	P. M. B
Mayo Foundation	G. M. Higgins	J. L. Bollman	E. V. Allen	E. V. Al
N. Carolina	W. C. George	H. R. Totten	R. W. Bost	R. W. B
N. Dakota	H. E. French	C. W. Telford	A. R. Oliver	A. R. O
Iowa State College (formerly *Ames*)	W. E. Biester	V. E. Nelson	D. L. Holl	D. L. H
Rutgers	J. D. Garard	M. A. Johnson	M. W. Taylor	F. H. P
McGill	J. B. Collip	B. P. Babkin C. V. Christie	R. D. Gibbs	W. B. R
Kentucky	O. J. Stewart	W. A. Price	M. M. White	J. W. M
Idaho	L. H. Stauffer	E. C. Jahn	H. S. Owens	M. R. K
Swarthmore	H. Brinkmann	R. B. MacLeod	H. J. Creighton	H. J. C
Oregon	W. D. Smith	E. S. West	C. Hall	A. Mour
Virginia	F. A. Geldard	G. T. Whyburn	J. K. Roberts	J. K. Rob
Johns Hopkins	W. B. Kouwenhoven	L. J. Reed	M. W. Pullen	M. W. P
Calif. Inst. of Technology	P. W. Merrill	H. Bateman	F. C. Lindvall	H. J. Fr
New York	A. E. Hill	G. J. Noback	D. Ludwig	D. Ludwi
Cincinnati	R. C. Gowdy	R. F. Reed	S. B. Arenson	S. B. Ar
Mich. State	R. Hutson	J. Hawks	P. J. Schaible	C. F. Ro
Arizona	E. F. Carpenter	Lila Sands	R. E. Heineman	R. E. He
Lehigh	P. L. Bayley	R. W. Hall	P. B. Carwile	A. Butts
Maryland	W. B. Kemp	C. G. Eichlin	C. E. White	C. E. Wi
Kansas State	R. K. Nabours	Martha Kramer	H. H. Laude	J. L. Ha
Col. of Medicine Univ. of Illinois	R. W. Keeton	G. von Bonin	W. H. Welker	I. Pilot
Pennsylvania State	W. B. Mack	J. L. Dean	L. A. Doggett	T. B. Ke
Oklahoma	F. E. Clements	M. D Wilson	L. E. Harris	L. E. Ha
State Col. of Wash.	H. H. Langdon	L. K. Jones	J. Sotola	J. Sotola
Wyoming	R. H. Bruce	A. P. Sturtevant	W. B. Owen	G. H. St
Rochester	B. H. Willier	S. W. Clausen	Q. D. Singewald	Q. D. Sin
Pittsburgh	C. G. King	J. S. Taylor	G. M. McKinley	W. H. En
Harvard	G. Jones	G. M. Fair	F. M. Carpenter	B. J. Bo
Western Reserve	C. J. Wiggers	W. G. Simon	E. Muntwyler	F. Hovorka
Princeton	L. P. Eisenhart	G. E. Beggs	C. W. Bray	H. N. Al
Duke	F. Bernheim	P. J. Kramer	H. J. Oosting	Bert Cum
California At Los Angeles	A. W. Bellamy	G. R. Robertson	A. H. Warner	W. M. W
Massachusetts Inst. of Technology	A. C. Hardy	W. C. Voss	J. B. Wilbur	B. E. Pro
Tulane	H. N. Gould	C. C. Bass	H. Cummins	H. Cumm
Wesleyan	M. C. Foster	H. B. Goodrich	C. L. Stearns	C. L. Ste
Smith	J. Y. Cann	Myra Sampson	L. T. Slocum	D. Montgo
Carleton	A. T. Lincoln	L. M. Gould		
Buffalo	A. R. Shadle		H. M. Woodburn R. N. Jones	C. F. Sc
George Washington	P. Bartsch	L. W. Parr	P. W. Bowman	P. W. Bo
Utah	C. M. Blumenfeld	R. S. Lewis	S. Flowers	S. Flowe
Carnegie Inst. of Technology	T. R. Alexande	W. R. Kirner	J. B. Rosenbach	C. R. Fet
Oregon State	F. O. McMillan	D. C. Mote	W. E. Lawrence	D. E. Bull

SIGMA XI CLUBS

Club	President	Vice-President	Secretary	Treasurer
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.....	W. A. Koehler.....	S. Morris.....	O. R. Ford.....	O. R. Ford
.....	C. E. Bennett.....	E. R. Hitchner.....	M. D. Sweetman....	M. D. Sweetman
.....	P. A. Foote.....	P. H. Senn.....	M. D. Cody.....	M. D. Cody
.....	F. Thorp.....	F. Thorp.....	P. G. Koontz.....	P. G. Koontz
.....	E. C. Timms.....	A. D. McKinley.....	W. Whitcomb.....	W. Whitcomb
.....	Anna Church.....	H. S. Thurston.....	E. B. Carmichael....	J. G. Carlson
.....	V. W. Adkisson.....	.....	L. E. Porter.....	L. E. Porter
.....	F. N. Briggs.....	.....	H. P. Olmo.....	H. P. Olmo
.....	W. W. Atwood.....	.....	P. M. Rope.....	P. M. Roope
.....	J. J. Brady.....	D. W. MacCorquodale	A. E. Ross.....	.....
.....	G. C. White.....	R. M. DeCoursey....	D. C. G. Mackay....	D. C. G. Mackay
.....	W. H. Shideler.....	.....	R. V. Van Tassel....	R. V. Van Tassel
.....	A. S. Edwards.....	.....	J. W. Nuttycombe...	B. J. Miller
.....	W. N. Lowry.....	.....	R. L. Anthony.....	.....
.....	F. M. Durbin.....	J. C. Ireland.....	J. E. Webster.....	J. E. Webster
.....	D. B. Swingle.....	H. T. Ward.....	P. L. Copeland.....	P. L. Copeland
.....	L. M. Roderick.....	H. H. Flor.....	H. E. Wirth.....	H. E. Wirth
.....	R. A. Studhalter....	H. F. Godeke.....	W. M. Craig.....	.....
.....	F. O. Smith.....	G. D. Shallenberger..	C. W. Waters.....	.....
.....	S. A. Wingard.....	.....	W. L. Threlkeld.....	.....
.....	C. W. Luh.....	C. M. Van Allen....	A. P. T. Sah.....	A. P. Sah
.....	W. A. Ver Wiebe....	C. C. McDonald.....	E. A. Marten.....	E. A. Marten
.....	C. R. Fellers.....	W. S. Ritchie.....	H. Van Roekel.....	C. P. Alexander
.....	D. R. Clippinger.....	C. A. Frey.....	H. H. Wolff.....	H. H. Wolff
.....	E. F. Smellie.....	R. E. Holzer.....	G. V. Martin.....	G. V. Martin
.....	R. G. Stone.....	J. E. Wildish.....	L. Misbach.....	I. Misbach
.....	R. E. Kirk.....	C. C. Whipple.....	W. H. Gardner.....	W. H. Gardner
.....	H. P. Pettit.....	D. R. Swindle.....	J. F. H. Douglas....	.....
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.....	D. P. Boder.....	.....	Helen S. Mackenzie..	.....
.....	J. S. Looper.....	G. H. Woollett.....	Lillian S. Wolfe.....	Lillian S. Wolfe
.....	J. A. Bullard.....	W. R. Adams.....	R. G. Daggs.....	R. G. Daggs
.....	S. Maeser	J. S. Williams.....	L. B. Linford.....	L. B. Linford
.....	J. K. Nicholes.....	.....	M. Marshall	M. Marshall

OFFICIAL ANNOUNCEMENTS

SIGMA XI EMBLEMS

All insignia of the Society are available only through the office of the National Secretary. They are made in various styles and sizes, and in white and yellow gold. Orders for these insignia are issued through chapter secretaries, and must be *prepaid*. Information about styles and prices may be obtained from chapter secretaries or the National Secretary.

DIPLOMAS FOR MEMBERS AND ASSOCIATES

These diplomas are available in any quantity at 10 cents each. Diplomas can be engraved with the name of the individual and of the chapter and the date of initiation at 30 cents each. Orders should be sent to the National Secretary, should specify whether for members or associates, and should be accompanied by check.

INDEX CARDS

Index cards for newly elected members and associates are available *gratis* upon requisition from chapter secretaries to the National Secretary. These cards should be made out in duplicate, one set being retained for chapter files and one set being sent to the National Secretary for filing in the permanent records of the national organization.

NATIONAL CONSTITUTION

Printed copies of the National Constitution, containing all amendments to date, and all recent interpretations as made by the national officers on request of chapters, are available at 9 cents each from the National Secretary.

CHANGES OF ADDRESSES

Chapter secretaries are asked to send to the National Secretary in October of each year changes in their enrollment lists as follows: 1. Names and addresses to be deleted from the previous list; 2. Names and addresses to be added to previous list; 3. Changes of addresses of those on previous list who may have moved to a new address since the list was submitted.

SIGMA XI STATIONERY

Stationery in the official color of the Society is now available for all chapters and clubs at $1 per 100 sheets and $1 per 100 envelopes. The letter sheets bear the Society's seal embossed in white but no printing. The envelopes are the official square envelopes used by the national officers. Printed heading on the sheets and printed corner cards on the envelopes can be provided at cost, when so desired.

EDWARD ELLERY,
National Secretary, Sigma Xi,
Union College,
Schenectady, N. Y.